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CANADIAN GEOGRAPHICAL JOURNAL

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THE CANADIAN GEOGRAPHICAL SOCIETY

OTTAWA, CANADA

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SPECIAL REPRESENTATIVES:

Ontario and Quebec: F. A. DALLYN

Toronto office — 21 King Street, E.

Montreal office — 1000 St. Antoine Street (Tel. UN. 6-5285).

Europe: S/L W. H. CORKILL, M. B. E., The Mead, West Dumpton Lane, Ramsgate, Kent, England.

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COVER SUBJECT:—*An autumn scene in the Gatineau district.* F. H. Wooding photograph

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Three is a small family for a meadow mouse.

Small Mammals of the Western Mountains

by IAN McTAGGART COWAN

Photographs by the author except where otherwise credited.

IN AN EARLIER article* I called attention to the intimate relationship between the geography, the plant life and the wild life of any region. This is true for the larger mammals, but is even more spectacularly illustrated by the smaller, earthbound creatures, the shrews, moles, mice, squirrels, pocket gophers and others that make up our rich, small mammal fauna.

The great diversity of climate in British Columbia results from its broad latitudinal extent and from the complex mountain systems placed across the prevailing winds. There are places in the province where the rain streams from leaden skies to almost 300 inches a year; while only three hundred miles away, the 10-inch rainfall evaporates from a parched, alkaline soil that cracks and dessicates under the searing heat of the summer sun. In each area small mammals of special adaptations thrive, but those that live under one set of conditions cannot survive the others.

Most people know only those mammals that annoy them, or that become tame readily or are otherwise obvious. Thus everyone knows something about the brown rat and the house mouse — both of them strangers from other continents. The lawn builder near Vancouver may be all too familiar with the activities of the mole even though he never sees the culprit; and what woman does not recognize a bat. The camper knows the white-footed or wood mouse that rustles in the grub pack and makes fine twin-toothed gouges on the bacon rind. Ground hog, gopher and field mouse are common acquaintances of the farmer; and almost everyone would recognize a skunk, porcupine or rabbit even if the degree of familiarity differed.

*Canadian Geographical Journal XLVII: 226, June 1952, Big Game of the Mountain Province.

The Rocky Mountain marten, most valuable of the forest fur bearers.

Beyond this group the more than 200 kinds of small-fry that make up the mammal fauna of the province live their fascinating lives unseen and unsuspected.

Scarcely an acre in the province below the rugged plantless crags of the high tops has not its quota of small mammals, usually running to between fifty and a hundred or more individuals. In one barren-looking plot of land in the woods, near Kamloops, I set out mouse traps on an area of 100 square yards and took thirty animals of eight different species. Nor was this unusual. The loose humus soil of the coast forest is honey-combed with the burrows of shrews, moles and mice; the alpine meadows are often net-works of tiny runways, and the rock slides of the mountain slopes are hives of mammal activity.

Most of the small forms belong to the night shift, and as the last slanting rays of the sun fade into the half-light of evening the woods and meadows come to life. Every-where is the rustle of scurrying feet, the twittering murmur of hunting shrew, and the gentle crackle of leaves heaved upward as a mole digs a new subway.

In the trees the squirrels, with noses wrapped in their bushy tails, sleep curled in their nests, while the soft brown head and large black eyes of a flying squirrel peer for a moment from a tree cavity before the animal launches itself into the blackness towards the half seen trunk of a nearby tree. As it lands with a thump on a piece of loose bark a silver-haired bat drops from its daytime hide and flutters swiftly into the luminous glow around the tree tops. A sharp squeak, cut off half-uttered, marks the first meal of a weasel, the smallest of the flesh eaters.

Every possibility of arranging a life has been used. Some kinds, such as the white-footed mice, adaptable and generalized, have been extremely successful. From the arid sage-brush flats of the southern Okana-gan to the dripping spruce forests of the Queen Charlotte Islands, from Vancouver to Atlin, and sea level to timberline, some variety of this mouse occurs. I have been interested to find it eating grasshoppers, and the seeds of cactus and cheat grass, on the plains. On the beaches of Table Island I found a population exploiting a new food source in the abundant limpets and small crabs to be obtained at low tide. I was intrigued to find here that every mouse had lost one or more toes. Could it be that

Just a dead pine stub but in it the rare tree mouse (phenacomys) built her nest and raised her young.

The warm dry nest of a lemm wa

the occasional limpet struck back and, clamping quickly to its rock, trapped the exploring toes of the mouse ?

The large family of field mice or voles has been almost as successful but adaptation to the great variety of habitats it has occupied has encouraged diversification until the various parts of the province are occupied by no less than six different kinds.

In the moist humus of the Fraser River delta the diminutive, slender, creeping vole digs its myriads of tunnels and grazes upon the under side of the turf. The keenness of the scent of this mouse was most graphically illustrated for me in an apple orchard. Many windfallen apples, that looked perfect from above, had been completely eaten out by a mouse that had tunnelled up from below.

Amid the sun-cured wheat-grasses of the dry-belt cattle-ranges, the slightly larger grey vole lives out its life often with never a drink of water from birth to death.

The giant of them all, the Richardson vole, rat-sized, but with short tail, lives the life of a muskrat along the alpine rills that burst from the snow fields. Its four-inch tunnels and pathways lead from streamside to the damp thickets of dwarf willow and the patches of lupine, heliotrope, saxifrage and mountain spirea that provide its food. This is one of the rarest of our mammals but like all voles it occasionally, for no apparent reason, outstrips all normal controls and explodes into seething myriads. Under such conditions I have seen mountainsides honeycombed with burrows and in the most recent outbreaks, one farmer, cultivating somewhat higher than his neighbours, had an entire alfalfa field destroyed and an irrigation ditch filled with earth by these voles working under the snow.

A close relative of the meadow mice is the red-backed mouse of the coniferous forest. It is almost the only small mammal that can make a living in the boundless spruce forests of northern Canada and the western mountains. This small greyish vole with its bright chestnut back is an important mainstay in the economy of the

The Drummond vole or field mouse, second in numbers only to the white-footed mouse.

f a lemm was occupied under the snow.

The lemming vole, smallest and rarest of the alpine mammals. A posed specimen.

forest. Though it eats many forest seeds it destroys also the cocoons of several of the most damaging forest insects. Furthermore it stands at the base of the forest food chain and feeds the weasels, marten, fisher and wolverine that haunt the same woodland and play so important a part in the fur industry of the nation.

In the meadows the voles, the big Richardson vole and smaller lemming vole and tree mouse (*Phenacomys*) pay no heed to the winter. When the frosts level the jungle that gave them food and cover during the summer, the snow soon substitutes. Warm and sheltered beneath the snow, these small creatures burrow and eat. In the lea of some stone or against a log a warm dry nest of soft grasses provides all the additional insulation necessary. Life goes on as before with only the cessation of breeding as an acknowledgement of the season.

The largest of the mouse-like rodents, so called, is the mountain beaver or sewellel. It looks more like a tailless muskrat than a beaver; dark brown, flat headed, with small ears, strong digging-claws on its front feet, and almost no tail. It is a burrowing rodent, living underground in labyrinthine tunnels dug in the loose, wet soil of the forests of the southwest corner of the province. A strict vegetarian it eats a great variety of green plants and roots and has the doubtful distinction of being almost the only wild animal that will eat rhubarb.

The semidesert animal community includes a number of species that probably live out their lives without the need of water even for drinking. The pocket mouse is one of these. A small grey-backed mouse with long hind legs and a long slender tail, it lives among the sage brush and cactus of the southern Okanagan valley. Two fur-lined pockets opening from its cheeks give it its name. These it packs with seeds and other food to be carried to the burrow for later consumption. All animal forms must have water in order to live and we are accustomed to regard drinking as the only method of obtaining it. In many parts of the world, however, mammals large and small have

The burrowing pocket gopher seldom ventures above ground. This one was caught in the act.

From coastal beaches to the alplands, almost everywhere there are white-footed mice, the most abundant of our mammals.

Below:
Beneath almost every log there is a network of runways made by the forest-living mice. Here the runways are marked with white grains to show their pattern.

been able to divorce themselves from this necessity and thus to colonize the hot, waterless deserts. Their adaptive techniques are much the same in all areas. They avoid the dehydration of daytime low humidity by becoming active only at night, when, even in arid regions, there may be some dew. Day is spent in a nest chamber well down in the soil — often in the damp-soil zone — so that water loss by evaporation from the lungs is prevented. Their normal water intake is supplied sometimes by green vegetation and succulent roots, often by a high-starch diet of seeds. Starch when digested yields sugar and water — water that may be used for all the bodily needs.

The pocket gopher is another of the dry squad. From birth to death it burrows in the earth, making small openings to the surface and throwing out mounds of debris. I venture that 99 per cent of them never see a puddle of water, a clear stream or even a muddy trickle, except perhaps during the spring thaw. The food of the pocket gopher is almost entirely green plants and succulent roots. The plants it may get by furtive trips a few inches from a temporary opening in its burrow system, but more often they are pulled in from below. It is a quaint experience to watch a sturdy weed quiver before your eyes and then, in short jerks, disappear into the ground. The pocket gopher is not nearly so wedded to the underground as is the mole. It still has legs and feet of normal form and well-developed eyes; its ears however are small, for large ears get in the way in a tunnel, and its mouth and front teeth have altered as an aid in burrowing. The teeth are thrust forward slightly to project outside the mouth, so that they can be used when the mouth is closed against the entrance of earth. The elaborate burrow system of the gopher includes, besides feeding tunnels that are under constant repair and extension, a nest chamber, many small vaulted expansions in the tunnel where one

can imagine the feeding, preening and other activities taking place, storage chambers, and other special pits or short tunnels where the faeces are deposited.

The number and kinds of mammals in the forest areas of the province varies greatly and is linked directly to the food sources available. In open woodland of deciduous trees, mice of several sorts abound. In the dense coniferous forests, where an anaemic vegetation grows on the deeply shaded floor, there is little to support life. Here it is

that the red-backed mouse thrives, often to the exclusion of other primary producers. Sometimes however, the spruce seeds, insects, mushrooms, small saxifrages, wood rush, cranberry and other shade-loving plants are shared with the white-footed mouse. Only on stream-banks, pond-margins, or in open glades does more abundant vegetation encourage the presence of the mammals with less adaptable food habits, the graceful, long-legged, very long-tailed, jumping mouse or the stout bodied field mouse. I suspect that the populations of the red-backed and white-footed mouse are rather closely limited by the food supply. The efficiency with which they harvest the forest floor is quite remarkable. Foresters, seeking to re-establish forests by distributing seed, have been completely frustrated by the white-footed mouse. Almost every seed, even those carefully buried, is found and devoured. Only the lavish hand of nature can afford to scatter enough seed to feed the mice and give the protection of numbers sufficient to produce the relatively few seedlings necessary for a new forest. The large investment in forest nurseries is, in considerable part, a testimony to the pertinacity of *Peromyscus*, the woodland white-foot.

In the trees above the forest floor the seed crop is shared by the diurnal squirrels and the nocturnal flying squirrels. From sunrise to sunset the squirrels comb the forest for their diet of buds and seeds, supplemented by such insects and dead meat the fates may put in their way. Two kinds of squirrels occur. The Douglas squirrel — named after the godfather of the Douglas fir, Scottish botanist David Douglas — and the red squirrel. They differ in colour, voice, forest preference and some habits. The former is olive brown above and buff to orange below and seeks the coastal forest

A cone of the grand fir is a heavy load for a Douglas squirrel.

National Parks.

The red squirrel of the pine forests is one of the day time feeders.

areas north to Rivers Inlet; it is closely associated with the important food trees, broad-leafed maple and red alder. The red squirrel, of white-abdomen and hoarse voice, inhabits the rest of the province and demonstrates its great adaptability. Both species build warm bulky nests of dry moss, dead leaves and shredded bark. The Douglas squirrel, in its dripping rain-forest, chooses tree cavities by preference. The red squirrel finds cold, rather than moisture, a major problem, and builds either a very large nest on the sheltered lower branches of a densely foliaged conifer, or occupies a burrow under some tree stump, decaying log or stone pile. Food storage is the rule and the heaps of cones, cut green before the seeds can drop, the maple seeds carefully buried, and the dried mushrooms each nicely balanced in the fork of a branch, help to keep life and warmth in the small bodies when snow blankets the ground and the mercury takes refuge in its bulb. The squirrels quite plainly have an interest in the forest and their interest may at times conflict with our own. The destruction of forest seed by them is probably not important but when they develop a taste for the bark of young pines or hemlocks, or the terminal buds of plantation trees, they may do damage enough to turn the forester's hand against them.

The flying squirrel is a true creature of the night. The dark grey-browns of its soft fur are shadow colours and its luminous black eyes are unusually large and adapted for gathering all errant rays of light from the night sources. It is as silent as the red squirrel is noisy and lives its life unnoticed and unheralded. A dull thump on cabin roof, the whisper of claws on bark, are all that betray its presence. In the glow of a flashlight, however, a darker shadow, bearing a single golden head-lamp, may be seen to glide in descending swoop from the top of one tree to the bottom of the next. A whicker of claws and the shadow vanishes. The flying squirrel does not fly, it glides. From each wrist a slender rod extends to support the leading edge of soft folds of fur-covered skin stretching from wrist to ankle. With four legs wide spread, the flying squirrel is kite-form, and, steered by its broad flat-furred tail, it glides from tree to tree. With the membrane folded it prowls the logs and ground for its food. Often, I think, the red squirrel's larder does double duty.

Above the forest altitudes, where the trees give up the losing battle with the elements, the sun's life-giving rays again reach the soil and it erupts in a welter of vegetation; meadows of dwarf willow, heliotrope, saxifrage, lupines and asters, drier uplands of heath, crowberry, lousewort, avalanche lilies; the hardy rock lovers, the fleabanes, moss campions, saxifrages and hosts of others, produce nutritious leaf, stem, bulb and seed.

The flying squirrel, seldom seen by day.

National Museum of Canada.

Here a populous mammal community has developed to fill all the ecologic niches. All have faced the common problem of the alplands — summer abundance followed by the freezing famine of winter. The ways in which the common problem has been mastered make an interesting story. In general there were three avenues of attack open to the early mammal colonizers of this rugged habitat. The winter could be avoided, anticipated or ignored. Each has been successfully applied by one group or another of the hardy fraternity.

The largest of the group is the hoary marmot or whistler. This is the giant of the woodchuck group of the squirrel family. It is a heavy-bodied, grey and white creature weighing up to thirty pounds. The whistler's annual life cycle consists of an 8 months' winter sleep interrupted by 4 months of eating and basking in the summer sunshine, always with one eye open for prowling coyote and the other searching the sky for the wheeling talons of the golden eagle. Eat when the sun shines, sleep when it doesn't; its even routine has only the briefest disturbance in early spring that sees to the needs of the next generation. A deep burrow, opening in the shelter of gigantic boulder to discourage the schemes of any prowling grizzly bear; a dry, warm chamber lined with suncured grasses, deep beneath the frost line; such are the provisions for winter and here the chill hand of hibernation reduces the marmot to an inert mass of fur, stiff, cold apparently lifeless. But somehow the influence of spring penetrates even beneath the snowbanks and the first avalanche lilies are greeted by the piercing whistle of the hoary marmot.

Several lesser members of the squirrel family that share the alplands follow the example of their larger relative. The Columbian ground squirrel, the golden-mantled ground squirrel and the chipmunk are all hibernators. The first is a relatively slender ground squirrel with greyish olive back, yellow abdomen, and orange nose. It is commonly known as a "gopher" and is one of the truly adaptable animals, equally at home in the grasslands of the warm valley bottoms, where spring is early and autumn late, and on the high tops where spring, summer and autumn merge into a brief interlude between winters. The Columbian ground squirrel is a grass-eater and stores no food for winter.

Not so its smaller relatives the two striped members of the fraternity. The mantled ground squirrel resembles a large chipmunk. It has two white stripes each with a black stripe on each side. The head and shoulders in summer are bright chestnut making this one of the handsomest of the province's mammals. The chipmunks are represented by four species and many different subspecies but all would be easily recognized. The mantled ground squirrel and the chipmunks are primarily seed eaters. Both have capacious internal cheek pouches (not the furlined type of the pocket mouse and pocket gophers) and can frequently be seen with these bulging with loads of seeds, en route to underground

Young flying squirrels before their eyes are open show the flap of skin from wrist to ankle that will become their gliding membrane.

The whistler or hoary marmot basking in the summer sun on the tumbled rocks.

storage chambers in the home burrow as provision against wakeful periods during their long sleep.

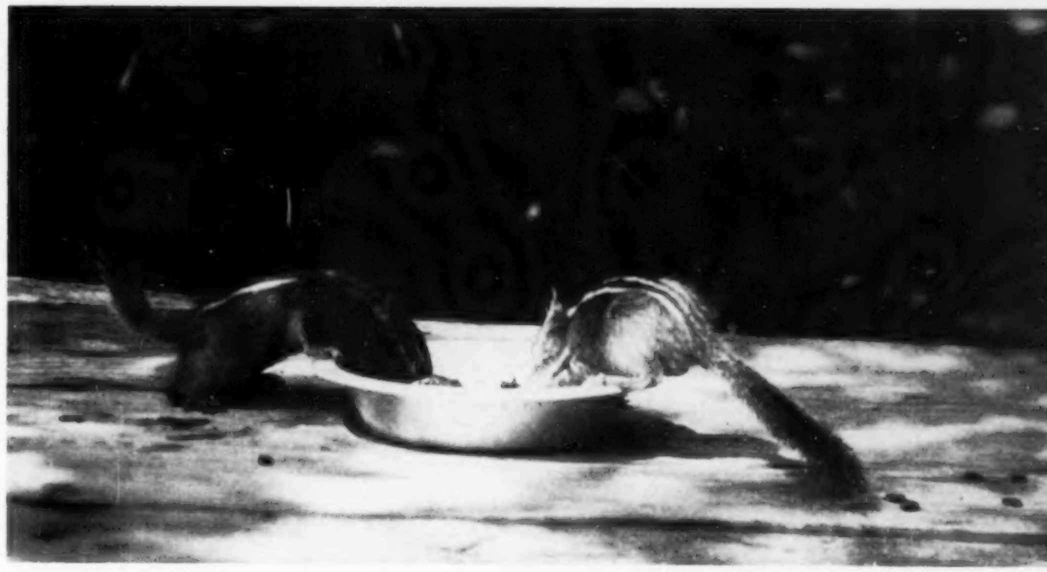
The smallest of the alpine hibernators is the jumping mouse that occurs also in meadowland and the brushy borders of forest openings at lower elevations. The young jumping mouse, just from the nest, resembles nothing more than a yellow-brown bumble bee on a long string — the 4 to 5 inch tail.

Two typical alpine mammals are by choice denizens of the tumbled masses of rock that huddle at the feet of the rugged crags and

Golden mantled ground squirrel.
Dan McCowan.

Not a beaver lodge, but the nest of a pack rat built in the open forest.

Chipmunks are frequent guests at the camp kitchen.



spill out into the meadows below. Their shelter makes provision for safe homes, protected runways and dry storage areas. Here the pack rat or bushy-tailed wood rat gathers its heaps of assorted debris; sticks, leaves, old bones and pieces of dried dung, are the usual components, but any debris, human or animal, may be added. The cup-shaped nest, warmly lined with the shed fur of marmot, rabbit or other neighbour, is sometimes within the heap, as often close by. The mountain pack rat is an industrious provider against winter needs and accumulates large heaps of vegetation cut and dried during the summer, willow-herb being particularly favoured. This animal remains active through the winter, foraging among the rocky tunnels buried beneath the protective blanket of snow. The pack rat has earned a bad reputation among mountain men for it finds man-made cabins a welcome substitute for rock slides. The results of a winter of habitation by these rats are hard to erase. Not only is the interior littered with debris and droppings, and mattresses, blankets and clothing torn, but the pungent smell characteristic of the animal lingers for years despite the lavish use of hot water and soap.

In every mountain range in British Columbia the rock falls are inhabited by the pika or rock rabbit. Its strident nasal squeal is better known to travellers in the hills than is the animal itself. Perched upon a large boulder in the midst of so many it resembles one more stone and escapes detection, further aided by the somewhat ventriloquial effect of its calls. Like a small grey-brown guinea pig, tailless, with circular ears and a small rabbit face, this relative of the hares is a true northerner and occurs from western Siberia to the Rockies. Through the long days and short nights of July and August the pika toils indefatigably. Day after day it scuttles to and from the meadows, almost hidden by its loads of leafage. This is all carefully dried and stored beneath large boulders. I have taken as many as fifty plant species from the hay piles of one pika. When the snows come its food supply is assured.

The insect-eating shrews and moles deserve mention in any discussion of the smaller mammals. Not only do the shrews include the smallest living mammals, but the most tremendous appetites of any. The pigmy shrew, four grams or so in weight, may eat three times that in insects every day and quickly dies if it cannot obtain food in such quantities. The shrews have other claims to fame as they are among the shortest lived of all animals. Few of the small species reach the age of ten months and none see the calendar round.

Pack rat or bushy-tailed wood rat.

National Museum of Canada.

Piles of broken rock are the home of the pika or rock rabbit. This one has a large whitish tick attached to its side.

The moles, of which three kinds plough through the ground of the Fraser River delta area, are the most highly specialized burrowing mammals of the continent. The plush-like fur, that lies with equal ease in either direction, the long sensitive proboscis and short sensitive tail make the animal almost as reversible as a canoe. Its sightless eyes are buried beneath the skin and ear pinnae have been lost. The heavy fore-feet are muscled to a tremendously distorted arm skeleton and form a combination that permits the mole literally to swim through the soil in search of the earthworms and insects that are its preferred food. Moles are solitary creatures, each living alone in its burrow system. The problem faced by a mole searching for a mate has long intrigued me — but there is ample evidence that the problem is not insoluble.

The insects have no relief from attack even in flight, for the night air over the province is the hunting ground of fifteen different species of bats each with its own little corner to fill. In the arid parts of the Okanagan Valley and the grasslands of the Cariboo the tiny yellow, black-faced bat, the social bat, pallid bat, fringed-tailed bat and lump-nosed bat wheel over the lakes and orchards and by day huddle in the fractured walls of cliff and canyon or the cool depths of an abandoned mine.

In the forests of coast and mountain the silver-haired bat greets the early evening from its daytime retreat, in the depths of a lightning blasted spar. Here also the Keen's bat and little big-eared bat dart and twist in the dim aisles between the trees.

Earlier I said that all possibilities of arranging a life had been used by the mammals. While this is generally true it is interesting to note that there are still opportunities without competition awaiting pioneering species. In California the red tree-mouse has developed a digestion and behaviour based upon the abundant supply

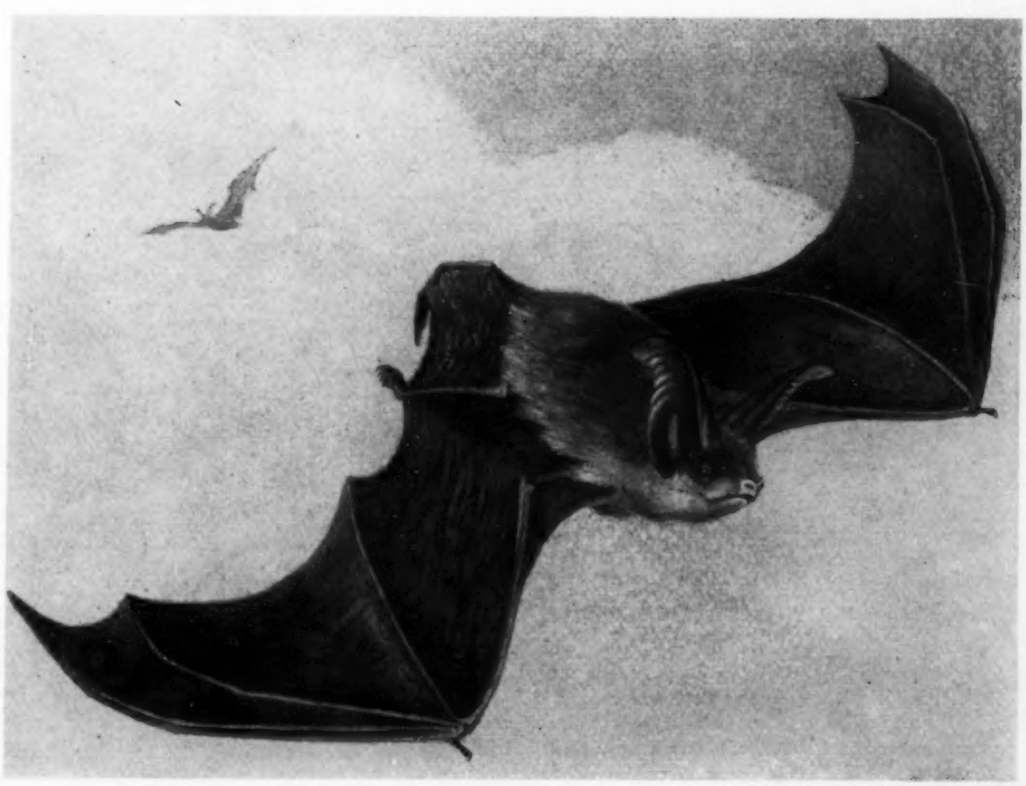
The pigmy shrew, the world's smallest mammal.

of needles produced by the Douglas fir and redwood. It feeds on the needle pulp and on some large branch, builds its nest of the residue along with softly shredded bark. For any animal combining these abilities with the adaptation to permit northern living there are unlimited possibilities, for no mammal has yet developed the ability to use the vast store of needles of fir, pine and spruce that sweep like a green tide from coast to coast across Canada's middle north.

Even for the small mammals this is a land of opportunity.

The big-eared bat of coast and mountain forests. From a drawing.

National Museum of Canada.



Poplar avenues are a familiar sight throughout the Rhone valley.

The Valley

by ANNE GLYN-JONES

Photographs courtesy Swiss National Travel office, except those by author.

NORTH of the quiet and lovely lakes of Italy, Como and Maggiore, whose beauties the Roman poets praised, are the Alpine glaciers of the Rhone and the Rhine. From these great glaciers, within a few miles of each other, flow two little milky streams, the one to race north past Austria into Germany, the other to meander west through the wide valley that the glaciers cleared for it, until it gathers strength in the open waters of the Lake of Geneva, and goes hurtling beyond to France and the Mediterranean.

There is a little town in this valley of the upper Rhone, called Martigny. Perhaps it was already a settlement when Hannibal struggled with his army across the Alps. The Romans knew the town, they called it Octodurum, and later on the little place grew to boast one of the earliest bishoprics of Christendom. You can reach Martigny from Italy, for you can follow the path that Julius Caesar's messengers took, and cross the Grand St. Bernard into Switzerland, with ghosts of Napoleon's army to hasten you on your way. Or you can come from France, if you care to creep across the high pass at the head of the Chamonix valley, leaving behind you as you go the great streams of ice that thrust down through every opening in the Mont Blanc Range, and drop down to the town, where the glaciers gouged out a great elbow bend between the mountains. But if you have no head for heights, then take the easy route, along the shores of the Lake of Geneva, round the head of the lake, where the Castle of Chillon, now shorn of its grimness, smilingly awaits the next photographer, and so you may come to the wide flat valley of the Rhone.

By the time you have gone the twenty-five miles up valley to Martigny, you will know the precipitous, pine-covered mountains, rent open here and there to show a high cascade or the beginnings of a ravine that

would take you up into the ski resorts under the Dents du Midi; you will have grown used to the vineyards clinging to the lower slopes, and you will be drowsy in the heat of the long straight road lined with poplars—poplars whose thin lines spread out athwart, as well as along, the valley, to break the winds that in winter roar between the mountains. If, when you reach Martigny, you decide to follow the bend of the river round to the left and go on up valley, then I hope that it will be early October; for this is the time when the Canton Valais celebrates the *vendanges*, the harvest of the grapes, whose cultivation the Roman legions taught to the people of the Valais. Even if you shut your eyes you would know where you were by the nearby creak of the wagons and sleighs laden with barrels of grapes, the far-away tinkling of cowbells, and over all the pungent, heavy smell of fermenting wine.

At Sion, twenty-five miles beyond Martigny, the flags of all the Cantons of Switzerland are fluttering gaily across the streets, the thirteen red and white stars of Canton Valais taking proud precedence, flowers and fruit decorate every corner, and monster bunches of mock grapes swing succulently down from the arches across the alleyways. In the centre of Sion rise two rocky hillocks, each crowned by an old castle, and on one of these the chief celebrations of the evening are to take place. On a small plateau near the top the little tables are set out, and the coloured lamps are strung along the crumbling walls of the castle. When evening comes there will be dancing and singing, and yodelling contests, celebrating the grape harvest

Sion. The hill on the left is crowned by the castle of Tourbillon, once the bishop's palace, for at the end of the sixth century the bishopric was moved from Martigny to Sion. On the other hillock is Notre Dame de Valère, a fortified church of the twelfth and thirteenth centuries.

that yields one of the cleanest, freshest white wines in the world.

Not far from Sion, a few sun-drenched miles farther up this isolated valley, is Sierre. Outside Sierre, half a morning's climb up the mountain road that in winter takes the sophisticated up to the snow playgrounds of Montana, there is an old grey-brown building, a grim rectangle whose steep roof is notched at the eaves in a series of regular steps, the style that the people of the Valais have used for more than seven hundred years. It is small, and around it is a small garden, and beyond the garden apple orchards thick in lush grass roll down into the valley. This is the Château of Muzot, and here, in less than three weeks, the

Between typical Valaisan chalets winds the path that leads up to the church at Raron.
A. Glyn-Jones.

On a hill-top, overlooking the village, is the sixteenth-century church of Raron, where Rilke is buried.

German poet Rilke wrote the fifty-five Sonnets to Orpheus and more than half the ten Duino Elegies which earned him a place among the most honoured of European poets. He succumbed to the charm of this austere valley when he came in 1921, and he stayed until his death in 1927. He lies buried in the tiny churchyard of Raron, a little farther up the valley.

It is on the way to Raron that one slips across the language border from French-speaking into German-speaking Switzerland. The border has shifted many times in the long history of the canton. Some three hundred years ago French began to push back German, and in the course of time won about twelve miles of the Valais. In recent years the tide has turned, and German is edging its way back down the valley. It is the tidal movement of the centuries.

To reach Raron one must leave the long road that drives straight through the heart of the valley, and go out on a side road that, like the branches at the side of a tree, push away from the stem into nothingness. At Raron, as at Sion, there are those strange rocky knolls splashed out from the mountain side, islands that resisted the passage of the glaciers long ago. The church is perched on the precipitous edge of one such knoll, and is reached by a steep footpath on which the wooden chalets keep the climber company for only the first few yards. The church and its little graveyard keep watch over the valley like a fortress of old, and here under the church wall, the very place from which he first gazed out over the valley that won him, is the grave of Rilke. There is a single briar blowing across it, and carved on the plain white stone are the words he himself wrote:

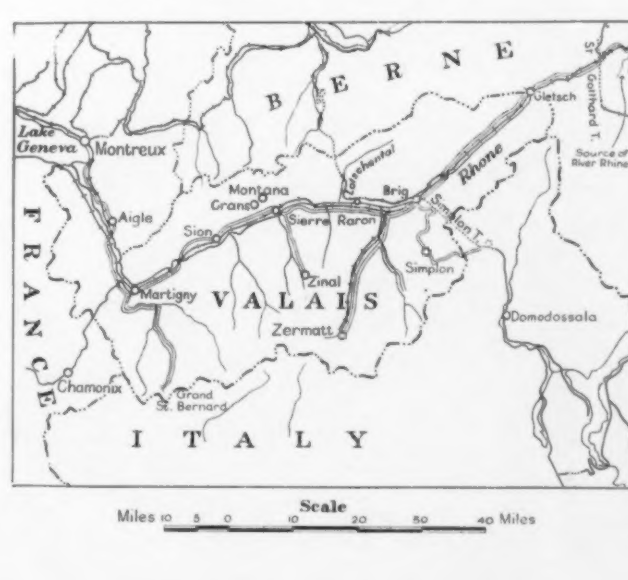
Rose, oh pure contradiction, desire to be
no-one's sleep beneath so many lids.

Did he know, when he chose those words as his epitaph, that the prick of a rose would bring on the disease from which he died?

Beyond Raron the valley narrows. High in the rock face on the left is the black smudge that marks the start of the Lötschberg tunnel. The train that takes that route

On the Sunday after Corpus Christi, known as Benediction Sunday, the people of the Lötschen Valley hold one of the most impressive religious processions seen in the country. This picture shows grenadiers in military uniforms once worn by Swiss regiments in foreign service.

carries the traveller from this brown valley of rock and poplar and vine into the other world of the Bernese Oberland, to high mountain pools full of fish and grasslands thick with flowers. Behind the rock face is the "lost" valley, the Lötschental, where things have changed little through the centuries, where the armies of the Swiss mer-



The Stockalper Palace was built in the years 1640-1650. The Stockalper family were wealthy merchant princes of the Valais, trading across the Simplon Pass to Italy. A. Glyn-Jones

cenaries are still remembered, and the uniforms of France and Italy and Spain in another era come out of hiding for the pageant, where grotesque peasant masks, as demoniac as any that linger in Africa, are still carved and worn.

And then comes Brig, where the flat valley ends, and no matter which way one tries to go on, one must climb — ahead, following the Rhone steeply to its icy origins; striking away into the mountains to the north, and perhaps finding the trails that will lead to a glimpse of the Aletsch Glacier, greatest on the continent of Europe, that twists its slow way down one range of mountains and past another, never within sight of a road; or, if you would turn south, there lies the Simplon Pass to Italy.

All up the valley one has seen the wooden chalet, the simple square house, the solid stone church, but suddenly at Brig are romantic facades, arches and balustrades and turrets — a little bit of Italy that has slipped north of the Alps and is sitting in astonishment among the wooden Swiss chalets. For three centuries there has stood at the foot of the Simplon Pass the Stockalper Palace, a fantasy of Roman arches, each tower crowned by a golden ball that shines in the evening light until only the palace seems real and the little town slips away into shadows.

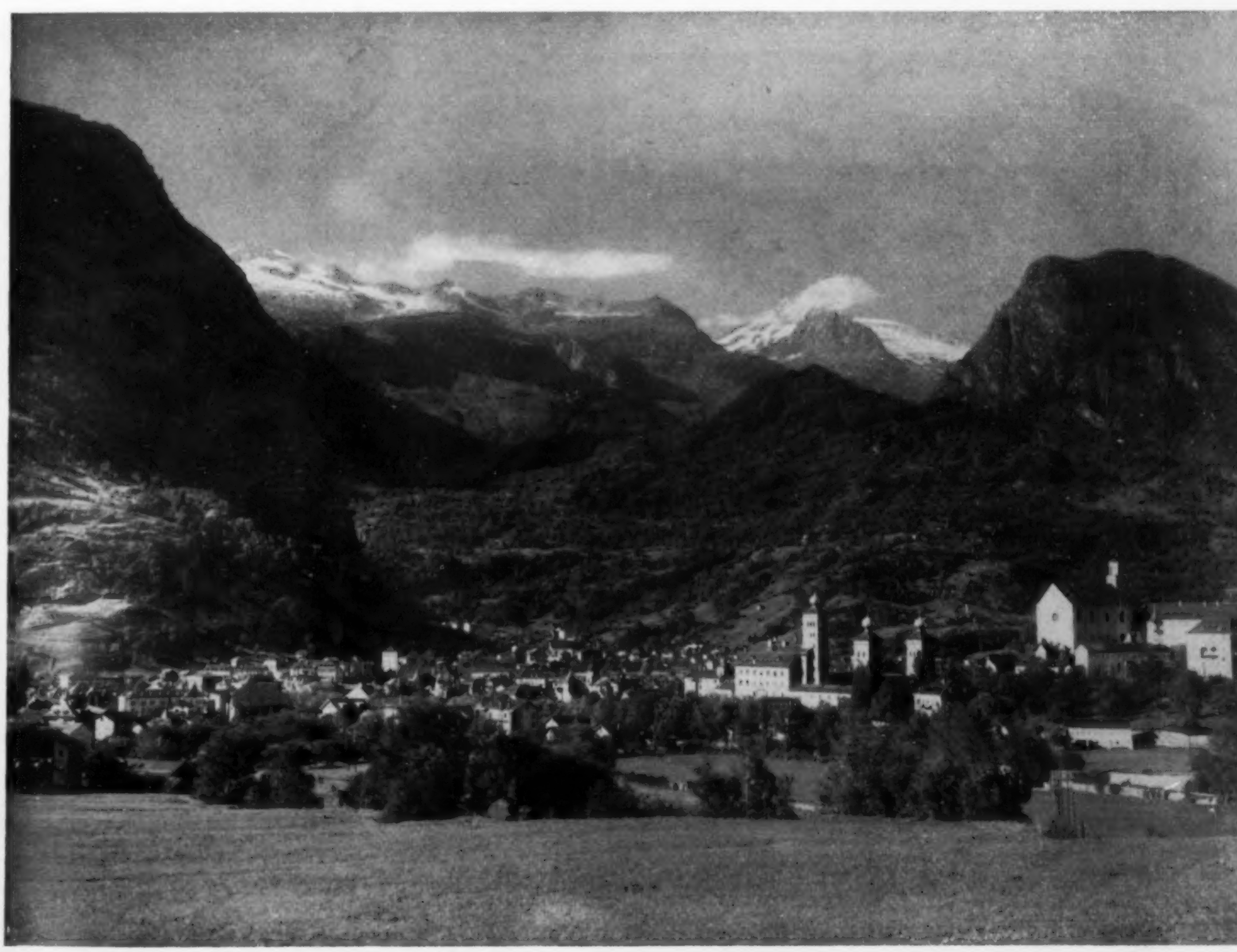
If this makes you long for Italy, then go on past the palace, for you are on the road to Rome. It is fifteen miles to the top of the pass, and the road is rough, but look back over your shoulder as you go, for the great white peaks of the Oberland are pulling up into the sky behind the mountains of the Valais, and if you are lucky you may see the giants of the Alps. To light your way comes a birch tree every mile, blazing out in burnished copper from a forest of fir and pine, until the trees are all left behind, and only the rock and ice remain ahead. And when you reach the divide — pause, for when you go on there will be no more Valais. Will you seek the grace of Italy, or will you stay in the mysterious communities of the Rhone? But when you have decided, make haste, for tonight the first snow will fall on the Simplon Pass, and the Valais summer will be done.

Through this narrow cobbled street in Brig leads the route across the Simplon Pass. In the background is the Stockalper Palace.

High on the Simplon Pass, the mountains rise beyond the valley.

A. Glyn-Jones.

Brig, where the flat Rhone valley ends and the climbing begins. The gold-tipped towers of the Stockalper Palace can be seen to the right of the town, on the road leading to the Simplon Pass.



Oceanographers are trained to do scientific work at sea.

Oceanography – Science of the Sea

by JOHN P. TULLY

Illustrations by DAVID DENBIGH

THREE-QUARTERS of the earth's surface is covered by sea water; it is deeper than the mountains are high; its salts contain more minerals than have been mined in all history; it controls the climate so that the earth is habitable. The sea dominates history, the present world, and our future.

Oceanographic research requires not only trained scientists, and the special equipment of the other sciences, but also specially equipped ships to operate in the coastal waters and far offshore. The expense is so great that only governments, representing the interests of all the people, can afford these researches.

Canada, through the Fisheries Research Board has taken a leading place in all phases of oceanography since 1910. Scientists from the Atlantic and Pacific Biological Stations have provided the knowledge that safeguard fisheries, such as Pacific salmon, that need protection. They have found new stocks, and improved fishing methods for others such as herring, cod and tuna. They have studied the environment of the fishes and are predicting when and where they will be plentiful or scarce.

In the post war expansion of oceanography Canada has a unique organization of effort. All the government departments having an interest in the sea have pooled their efforts in a Canadian Joint Committee on Oceanography. Each contributes a share of the costs, and all share the data and results. At the Atlantic and Pacific Biological Stations this committee operates oceano-

graphic groups, which carry on the exploration of the seas adjacent to the Canadian coast. They provide oceanographic information for the government, and industry, and develop our knowledge of the sea and its resources.

Scientists trained to work in the sea are required, so an Institute of Oceanography was established at the University of British Columbia. Here chemists, physicists, biologists, and geologists are given instruction in present knowledge, and training in how to do scientific work at sea. These graduates go into fisheries, industry, the oceanographic groups, or one of the government departments concerned with the sea.

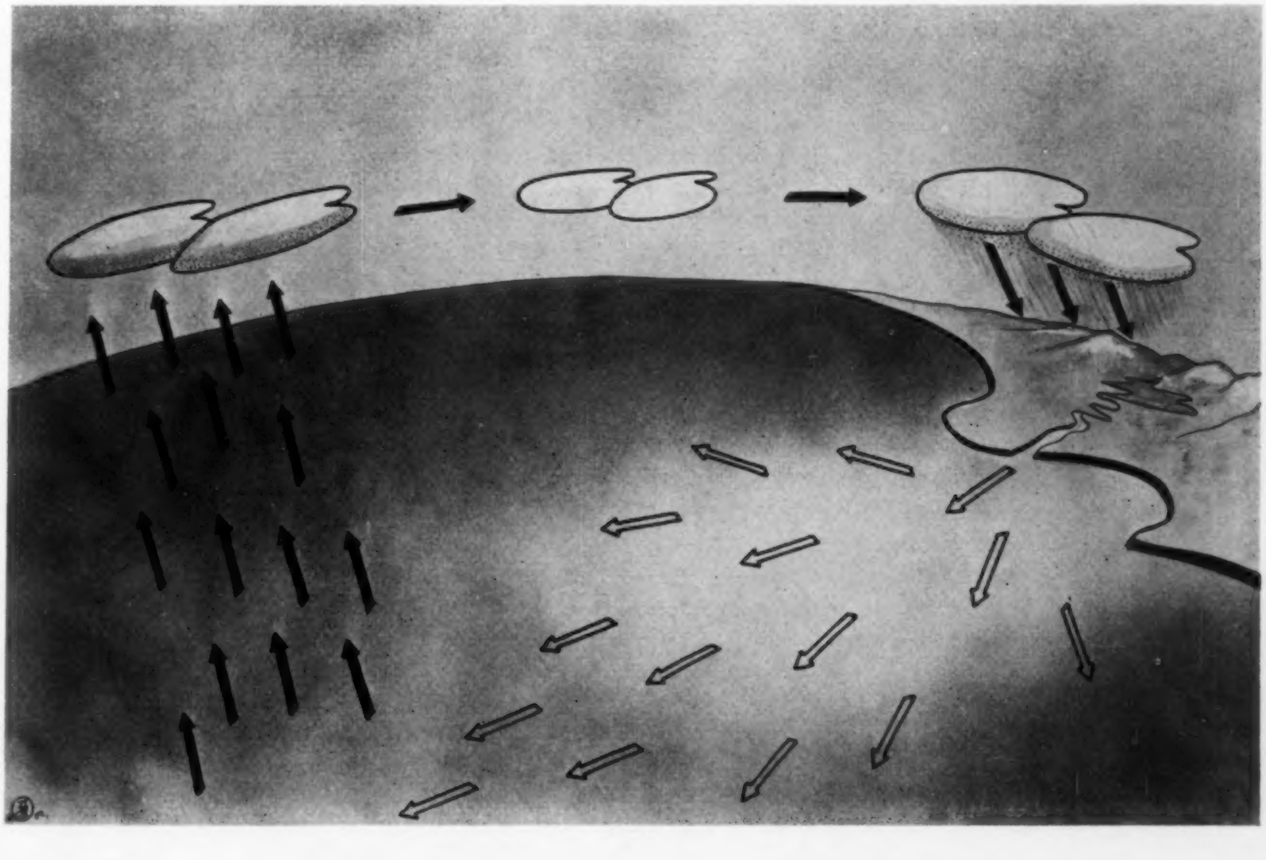
The development of the sea, like the development of new lands requires the patient work of many people to solve the problems, exploit the resources, and learn the ways of the new world. So in the sea the accumulation of knowledge has come in recent years from *Oceanographers* who are the "Scientists of the Sea". They apply their knowledge of the sciences to the explanation of the sea and its mysteries. On land we regard scientists as people who carry out profound experiments and calculations in special laboratories. In oceanography these scientists go to sea and carry out their studies in ships that are continually moving.

Processes in the Sea

The processes in the sea are so great as to defy imagination. The sun shining on Bikini atoll in the south Pacific, provides more energy in two days than was released by the two atomic bombs. The sun evaporates enough water from the ocean in one day to keep all the hydro-electric plants in the world running for 10,000 years. This cycle of evaporation, cloud formation, and rain is the greatest process.

Limestone, the most plentiful of all rocks on the earth's surface is made entirely from shells of clams, mussels, starfish, coral and such sea animals. These live in the shallow seas bordering the continents, where they extract lime from the sea water to form their shells. In the course of time they live, grow,

The cycle of evaporation, cloud formation and rain. When the sun heats the surface of the sea some water evaporates, invisible steam rises and condenses to form clouds. Rain falls on the land and the water drains to the coast in streams. The fresh water flows out over the salt sea water.



and die, building limestone beds of great thickness. Most of these are built in warm seas where there are more shellfish, and the shells are heavier, than in the temperate or arctic seas. During the great upheavals of the earth's crust these beds have been raised out of the sea to form land and mountains. Then erosion starts. Lime is dissolved, little by little, in the rain water and so is returned to the sea. There it is used again to build sea-shells. As a result the lime (calcium carbonate) in the sea remains constant.

The respiration of animals and plants is another great process in the sea. As sea water washes over the gills of the fish, shellfish, and zoo-plankton, the oxygen dissolved in the water is exchanged for carbon dioxide from their bodies. There is about five milliliters (a king size cigarette full) of oxygen in a quart of sea water. This would supply a herring for about half an hour. Considering all the life in the sea, the oxygen would be quickly exhausted if it were not being continually replenished.

The surface waters are aerated by the winds which mix air with the waves. This process is most efficient in the winter, when the winds are strong. However it would not supply all the oxygen required in the summer when the sea is calm, and the animals are growing and multiplying. Fortunately the plants which grow in the upper levels of the sea take in carbon dioxide when the sun shines on them, and give off oxygen and carbon dioxide. In the winter, when the plants die off and the animals are resting, the water gets sufficient oxygen from wind aeration.

Ocean Currents

Ocean currents are much less spectacular than the winds, or movements of the earth's crust. They were hardly recognized by the early explorers; they were not charted until the turn of the century; and they are not fully understood even yet. However, next to the sunshine and the earth's rotation, they are probably the most important factor in making and controlling our climate.

If the oceans were stagnant the tropics would be hotter than the Red Sea. They would be unbearable. The arctic regions would extend far south covering Canada, Northern Europe and Russia. The temperate zone would be desert. Less than half the world as we know it would be habitable. However, these things cannot be, because of the great ocean currents.

In the tropics the sun, being directly over head, heats the ocean to a depth of a few hundred feet. But as we proceed towards the poles the sunlight strikes the curved surface of the earth at smaller and smaller angles so that much of the light and heat is reflected from the sea, and does not enter the water. The efficiency falls off very rapidly so that in Canadian latitudes the heating is only three-quarters of that at the equator. Not enough heat reaches the poles to melt the ice.

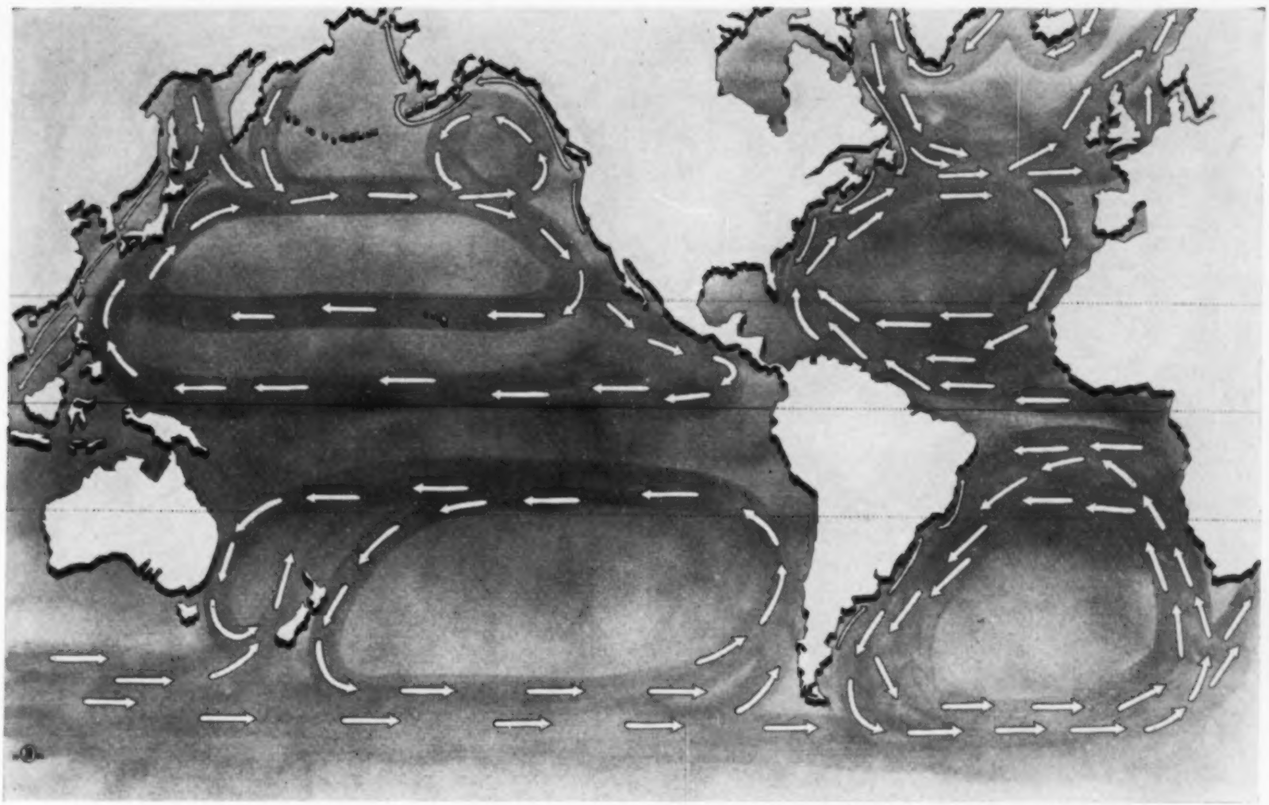
When the sea water freezes the ice is fresh, or nearly so, and the salt accumulates in the water under the ice. During the winter when the arctic seas are freezing, the sea water becomes more and more saline, and sinks. During the summer the ice melts, forming fresh water which floats on the surface.

The oceans are dominated by the wind. The wind is caused by the difference of the sun's heating in the arctic and tropic regions, and the eastward rotation of the earth.

In general, the tropical winds blow to the west. The tropical waters move westward, heating as they go, so that the warmest water in the North Atlantic Ocean is in the Caribbean Sea. The arctic winds are also predominantly to the west, so the coldest water is found around Greenland, and in Baffin Bay.

In the North American latitudes between the two extremes of tropic and arctic, the prevailing winds sweep the waters from Nova Scotia across the ocean. This West Wind Drift draws the water from the north and south to form a vast current—six hundred miles wide—moving twenty to thirty miles a day towards Europe.

From the Caribbean Sea, the Gulf Stream



The great ocean currents circle round the ocean basins. The water in them flows thousands of miles, heating the cold regions, the cooledwater continuing its flow back to the tropics where it is reheated.

flows close along the United States coast. Off Florida, the current is seventy miles wide, three thousand feet deep, and flows at four miles an hour. Off New York it is nearly two hundred miles wide, about a thousand feet deep, and flows about two miles an hour. From there it veers seaward to the Grand Banks off Newfoundland.

At the same time, the Labrador Current flows southward along the Canadian coast at twenty to thirty miles a day. It brings icebergs and a bitter climate south into the Gulf of St. Lawrence and past Newfoundland, where it meets the warm waters of the Gulf Stream over the Grand Banks.

These mixing waters are taken across the ocean by the West Wind Drift. Off the coast of Europe the current divides. Part flows north, moderating what would be a bitter climate in Britain and Norway, and reaches the Arctic Ocean. The greater part swings south, tempering the coasts of Spain and Morocco. In the vicinity of the Canary Islands it turns westward to the Great Equatorial Current, where it is reheated on the way to the Caribbean Sea.

These great ocean currents control the climate. Labrador has a subarctic climate, while Britain, in the same latitude is temperate. There is no temperate climate in the western ocean, because the cold and warm waters meet on the Grand Banks. Here there is a sudden change from subarctic to subtropical climate, and icebergs may be found melting in seas warm enough for swimming. Ships off Nova Scotia are sometimes laden with ice when the sea spray freezes on them during the winter storms. If they sailed for Halifax they might sink from the weight of ice, so they turn eastward, and after a few hours steaming they shed their ice in the tepid waters of the Gulf Stream. In contrast the whole eastern side of the ocean is temperate, from Norway inside the Arctic Circle, to Dakar in the tropics.

These great currents have affected the course of history, and even today they determine the route of commerce. Columbus discovered America in 1492, by sailing with the tropical current on the southern route across the Atlantic. He averaged four miles an hour on this epic journey, with a favourable current of almost two miles an hour. It was a greater feat to return to Spain

against the current, in his clumsy ships, than to find the New World. Although the northern route was only half as long, the French and British had to sail against the West Wind Drift on their voyages of discovery. Because of these great currents Spain had the advantage, and was able to exploit the riches of Mexico, while the explorers of France and Britain not only fought the sea, but reached a coast where there was a bitter winter climate dominated by the cold Labrador Current.

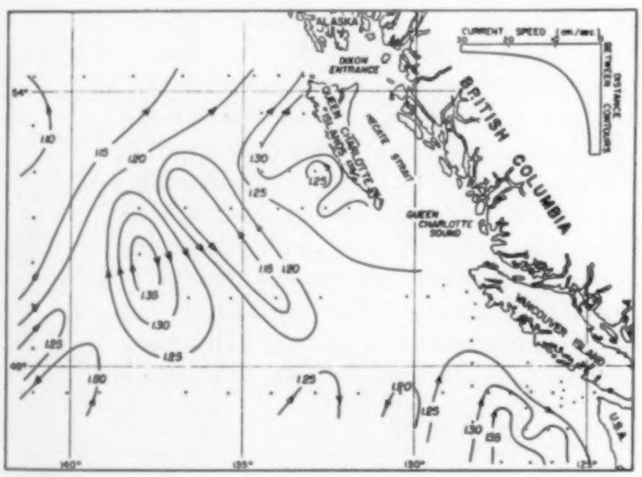
If it were not for the iceberg laden Labrador Current, Montreal, and not New York would be the great seaport for European trade with America. Montreal has every advantage. It is deep inside the Atlantic seaboard, and has a cheap water shipping route through the Great Lakes to the centre of the continent. But it is closed by ice for a third of the year, and the approaches past Newfoundland are menaced by icebergs for half of the remaining eight months. In spite of this, Montreal held the advantage until the railroad building of the last century decided the issue. Then, with continental transport no longer a major problem, shipping came south of the Grand Banks, avoided the icebergs, and settled in the all-weather port. New York still owes much of its eminence to the oceanographic conditions in the northwest Atlantic.

Although the Pacific Ocean is more than twice as large as the Atlantic, and is protected from arctic ice by the close conjunction of Alaska and Siberia, the circulation corresponds to that in the Atlantic in almost every respect. The tropical current flows westward, being heated on the way, so that the warmest water is around the Philippine Islands. The coldest water occurs along the coast of Siberia in the Bering and Okhotsk Seas. A West Wind Drift originates off the northern coast of Japan and draws warm water from the south and cold water from the north. Like the Atlantic coast of America, Japan has hot summers and rigorous winters. The extremes are not as great as in the Atlantic counterpart, because there are no icebergs, but the tendency is the same.

The prevailing westerly trade winds in the temperate latitudes carry the mixed waters across the ocean, close to the Aleutian Islands chain. The great transocean drift approaches the coast of America in the vicinity of Vancouver Island and divides about four hundred miles offshore. Part turns north carrying a mild climate far into the Gulf of Alaska. The remainder turns south moderating the climate in California and eventually joins the tropic flow which extends halfway around the world in this greatest of all oceans.

These currents wax and wane with the seasons. The warm currents are strongest in the summer, the cold currents in the winter. The currents are sinuous, meander in their course, and shift their position from year to year, so that the pattern of ocean circulation is complex and ever changing.

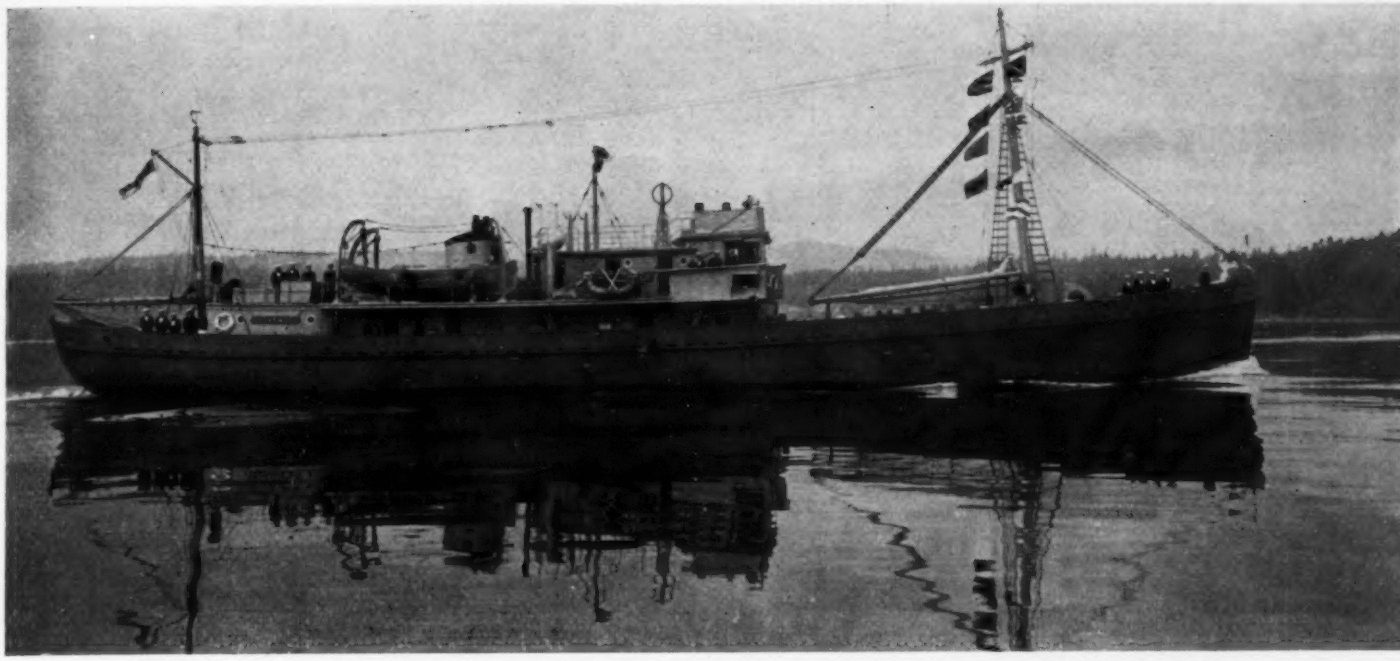
Although the great ocean currents control our climate, and make life possible on the earth, they are slow and cannot be seen. They have been charted during the last hundred years by the patient piecing together of information from the drift of ships and from oceanographic investigations.



Currents flow along the lines of equal pressure, the lightest water on the right in the northern hemisphere.

Coastal Currents

When the sun heats the surface of the sea some water evaporates, the invisible steam rises, and condenses to form clouds. The salt is left behind so that the mid-ocean in the warm latitudes is very salty. The clouds rain over the land and this fresh water drains to the coast in the creeks and



H.M.C.S. Cedarwood, *a Canadian naval oceanographic research ship. This vessel has been to the Arctic and has explored much of the Pacific Ocean off the British Columbia coast.* R.C.N.

rivers. The fresh water, being lighter than the salt sea water, flows out over the surface. It mixes as it goes, to form an upper layer of brackish water, whose depth and extent depend on the size of the river. This current turns along the coast and joins with the flow of other rivers to form a coastal current. It belongs to the land and in the northern hemisphere circulates to the right around the continents. The great currents circulate to the right around the ocean basins, so that these flows always oppose each other.

The coastal currents in Canadian waters are strongest in May and June when the spring freshets of the big rivers reach the sea. At this time the coastal currents are ten or more miles wide and are well defined. Later in the season they recede as the river flow decreases, and they are opposed by the coastal winds. However they are always present to some degree.

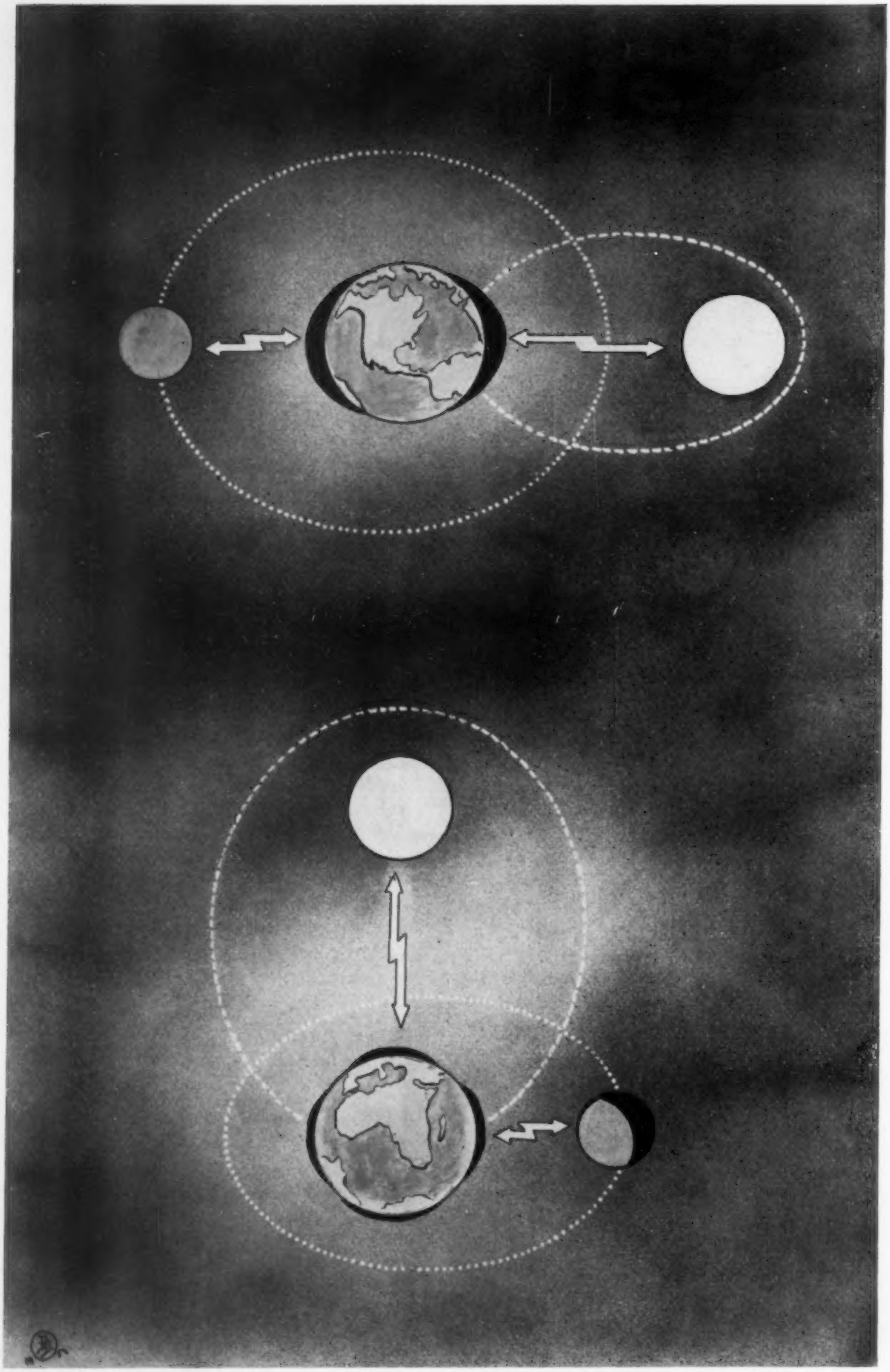
The cold water from the Gulf of St. Lawrence flows south past Nova Scotia separating it from the warm waters of the Gulf Stream. On the Pacific Coast the Columbia and Fraser Rivers create a north flowing current. In Alaska the Yukon River causes a brackish coastal stream which can be traced through the Bering Sea into the Arctic Ocean.

Along every continental coast there is an inshore current of mixed fresh and sea water, and an opposite current of ocean water offshore. The boundary of these two is marked by floating seaweed, and by sudden changes of temperature and saltiness.

Tides

In coastal waters, along the shore, the rise and fall of the tide, and the tidal currents are much more apparent than the great ocean or coastal currents. The tides were observed by the Greeks. Pytheas, about 325 B.C. attributed them to the influence of the moon, because they rose and fell with the moon. However, it is only in recent times that their cause and behaviour have been explained, and prediction of the tides only became general in the middle of the last century (1832).

The great scientist Newton (1642-1727) discovered that all masses attract each other. The earth holds together because all the parts attract each other. The moon, the sun, and all other heavenly bodies hold together because of their own force of gravity. Also the earth and moon attract each other, but the moon rotates around the earth at a speed and distance so delicately balanced that their mutual attraction is exactly equal to the moon's tendency to fly off at a tangent into space.



Tide-producing forces. When earth, sun and moon are in line the forces act together to produce spring tides. When sun and moon are at right angles to the earth the forces oppose each other and tides are small.

This is true of the earth and moon as a whole, but the side of the earth closest to the moon is attracted a little more strongly than the centre, and tends to move towards the moon. This force is not great enough to shift the solid crust, but it is sufficient to move the liquid ocean. The result is a high tide on the side nearest the moon. The side of the earth farthest from the moon is attracted less than the average, and tends to fly off into space as far as the earth's gravity will allow it, so there is also a high tide opposite the moon. The moon rotates around the earth from east to west in 24 hours 52 minutes, followed by two high tides, which become later each day by 52 minutes.

The earth and the sun also attract each other in the same way, but with much smaller forces because the distance between them is much greater. However there are two sun tides which follow the sun around the earth once every 24 hours.

When the moon is full, the earth is between the sun and moon. The near tide of the moon occurs at the same time as the opposite tide of the sun. Then the sun and moon tides reinforce each other and the tides are big, or "spring". The same is true during the new moon, when the moon is in the middle. However when the moon is in the quarter the sun and moon are at right angles to each other from the earth. The low tide of one coincides with the high tide of the other, so that the sun and moon tides oppose each other, and the tides are small, or "neap". Thus the tides are big and small in alternate weeks, as the moon's phase progresses through new, first quarter, full, and third quarter in the lunar month of 29 days.

If the earth were covered with water these tides would follow the moon and sun in their daily circuit, and would be greatest in the tropics and least at the poles. However there is land in the way so the tidal waves swing around the ocean basins, like water swished around a bathtub. At the centre there is no tide, but the height increases with distance. Thus the tidal rise at Hawaii, near one centre of rotation in the Pacific, is about one foot, while at Prince Rupert which is about 3,000 miles distance, the rise is 24 feet.

As the tide rises, water is drawn towards the crest of the tidal wave from both sides, at all depths. In the ocean where the water is two to three miles deep, a tidal rise of ten to twenty feet requires only a few feet of horizontal movement, so the tidal currents in the ocean are very small. However in the shallow seas near the coast the movement may be one or two miles, and the currents are noticeable. The direction of the current is always changing as the tidal wave swings around the ocean, like the spoke of a wheel. Thus a ship rotates twice around its anchor in a tidal day, and a log in the water floats twice around in a loop.*

As the level of the ocean along the coast rises, water, seeking its own level, runs into the bays and inlets, then as the ocean tide falls below their level, the water runs out again. Thus the rotary flow becomes an in-and-out flow in coastal seaways.

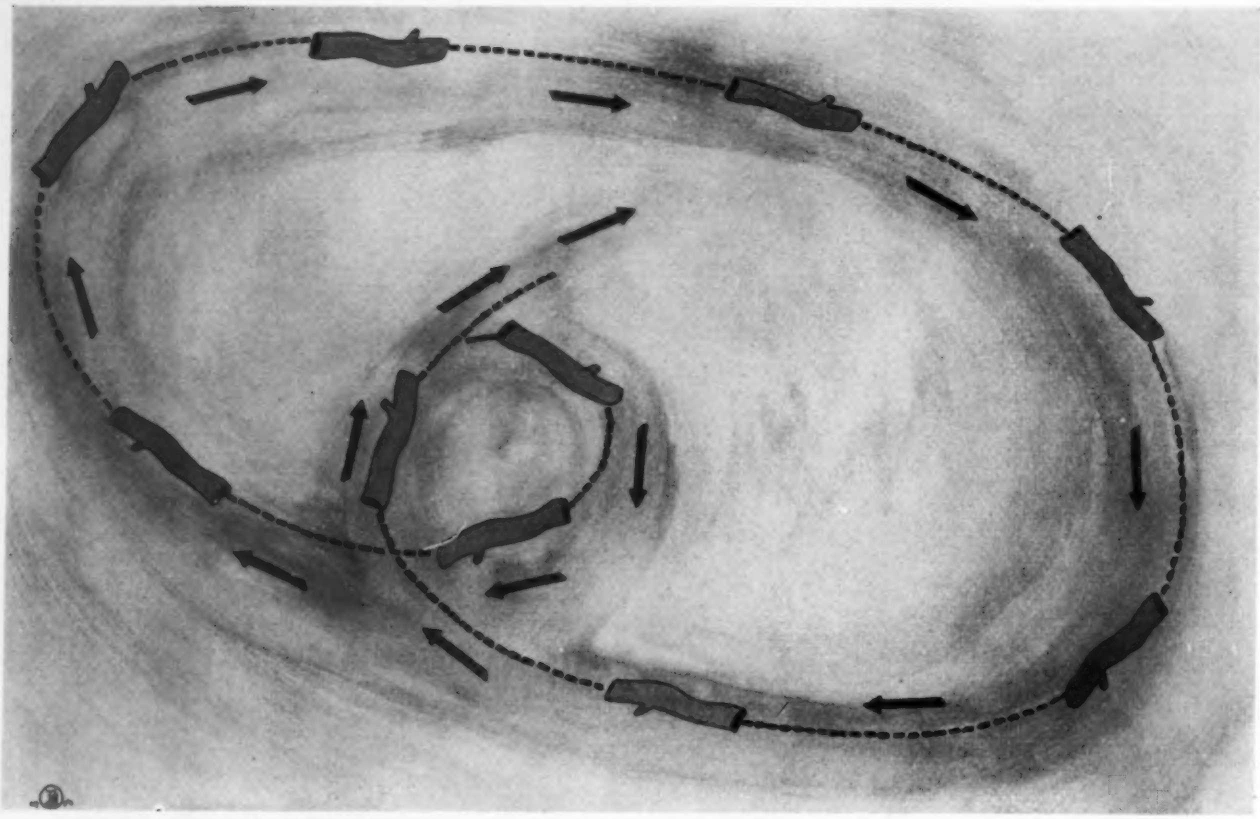
Tides are of immense local importance because of the ever changing sea level and currents in ports and coastal seaways. They flush the harbours, and keep the waters mixed, but they do not contribute to the great ocean currents. Due to the tides the water moves in and out, or around in loops but it doesn't go anywhere. The movement of water over long distances is due altogether to the coastal currents caused by the discharge of the rivers, and the ocean currents caused by the prevailing winds, and the sun's heating.

Weather in the Sea

Conditions in the sea are continually changing. The tides flood and ebb twice each day and the seasons progress through the year. Each of these cycles is to some extent similar, and to some extent different. We can say in a general way that the coastal seas of Canada are warmest in August, about a month later than the highest air temperatures and coldest in February, but each day and each year are different.

The greatest variations occur at the surface, where the sun's heating and fresh water

*See figure on page 156.



The direction of the tidal current is always changing, so that a log floats twice around a loop in a tidal day of 24 hours 52 minutes.

from the rivers are felt. These effects decrease with depth till constant conditions are obtained the year round below a thousand feet. In the upper region the passage of the seasons is marked by an annual temperature cycle of lesser magnitude than in the atmosphere, but not less significant. The greatest range of temperatures occurs in protected harbours and bays which become very warm in summer, and often freeze in winter. The climate is more moderate in open seaways because the surface waters, which exchange heat with the atmosphere, are mixed with the deeper, more constant waters, by the wind. In fast flowing straits and seaways the waters are continually being mixed so that the temperature remains very nearly constant throughout the year.

The salinity varies with the discharge of the coastal rivers rather than with rainfall. The big Canadian rivers have very little flow in the winter, because most of the precipitation is stored as snow on the land. In the spring the snow melts and the rivers flood. All the winter precipitation reaches the sea in May and early June. Thus the salt content of the coastal waters is low in the early summer, and highest in the late autumn. It is only on the Pacific coast islands that the winter rains reach the sea and lower the salinity in December.

These many variations of weather and climate are recorded by daily sea water observations at many places along the coast: at the lighthouses, at lightships, from steamers on the ocean, and the weatherships. Comparing these records with the biology we find that life in the sea is very sensitive, and each species seeks regions of suitable climate where its habits respond to the seasonal cycles.

Observing the Sea

The most common method of observing the sea is to take water samples, which are analysed on shipboard for their properties. The sampler is a metal tube with hinged lids. This is attached to a thin wire rope and, with the lids open, is lowered to the desired depth in the sea. When it is in

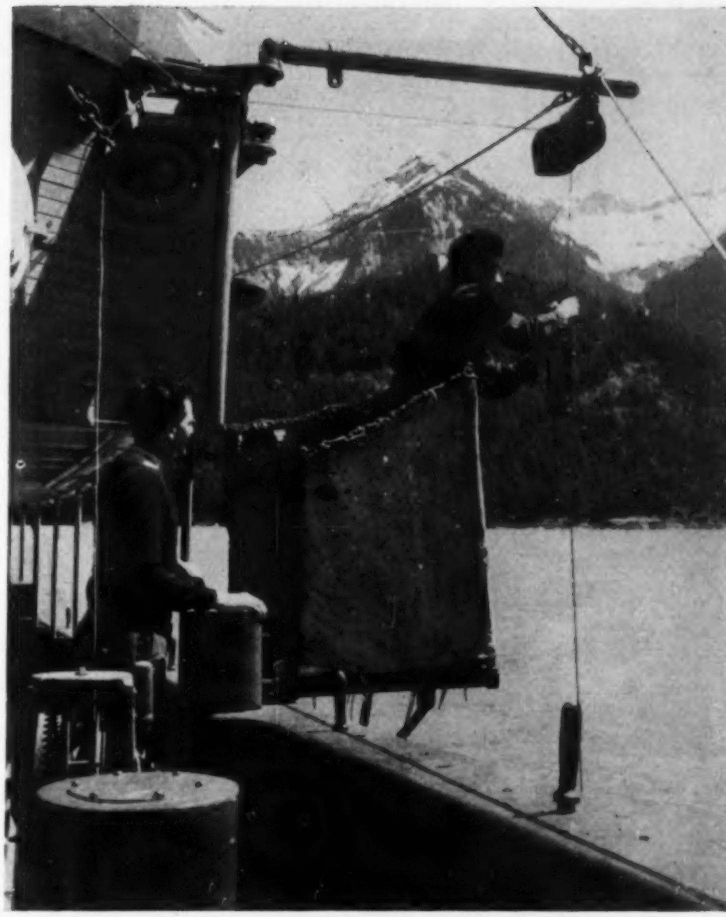
position a brass weight with a hole in it slides down the line, striking the sampler, closing the lids, and trapping a sample of water. These samplers usually have a special thermometer attached which reverses, end for end, when the lids close, and records the temperature of the water. The gear is arranged so that a large number of samplers can be placed on the wire line as it is lowered, and taken off as the line is raised. In this way we can observe the sea water at any number of depths from surface to bottom of the deepest or shallowest seas.

The samples may then be analysed for their salt content, the nutrient elements, or any other properties by the special methods that have been worked out by research chemists.

There are many other instruments such as the BT or Bathythermograph (depth-temperature-recorder) which looks like a miniature space rocket. It can be dropped on a long thin wire from a ship under way. It dives to the bottom, and when pulled to the surface carries a record of the temperature at various depths. There are many types of current meters to measure the flow of water, but these can only be used in quiet waters where a ship will ride steadily at anchor.

Currents in the ocean are calculated. Knowing the temperature and salinity of each sample of water from the surface to bottom at a position in the sea, one can calculate the average density and pressure. Knowing this at a number of positions in a region, a chart may be prepared showing lines of equal pressure. These correspond to the isobaric charts used in the prediction of weather. The currents, like the winds, flow along the lines of equal pressure. In the northern hemisphere the lightest water is on the right when looking downstream.*

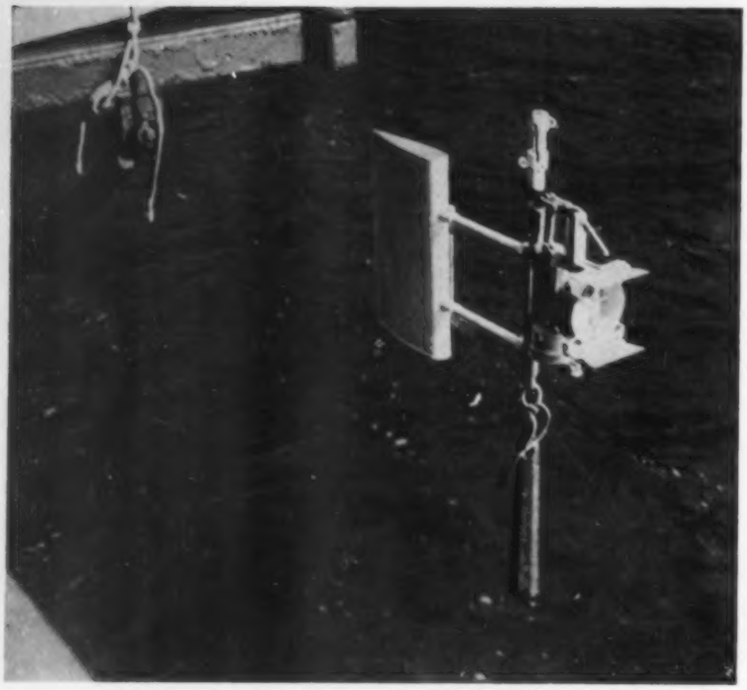
In seas adjacent to the coast of Canada the natural regions are being examined individually. These are the coastal inlets, the larger straits, the coastal seas, and the ocean offshore. Since the conditions are continually changing, each region is examined in detail a number of times throughout the year. The



Above:—The seawater sampling bottle is fastened to the sounding line on H.M.C.S. **Cedarwood** ***during observations in the Strait of Georgia.***

Right:—The Bathythermograph looks like a miniature space rocket and can be dropped on a wire from a vessel under way. It dives to the bottom and when pulled to the surface it carries a record of the temperature at different depths.

* See figure page 152.



Above:—The Ekman current meter records the direction and speed of the currents at great depths in the sea.

Below:—Plankton may be caught in special cone-shaped nets which are towed at the correct depths.

properties of the sea water, the currents, and the effects of tide and season are determined. In these surveys the temperature, salinity, and many other properties of the water are observed from surface to the bottom, at a large number of positions, in as short a time as possible. Each survey describes the oceanographic conditions at one time, and the effects of the tide or seasons is found by comparing successive surveys. However these surveys are tedious and costly, and the results are not known until long after the observed conditions have passed. To get around this difficulty, daily sea water observations are made at strategic points in the region, and compared with the results of the surveys. Each type of oceanographic condition, and its duration, can be recognized when it occurs again, and frequently it can be predicted. As the oceanographic character of one region is solved, the effort is shifted to another region, so that in the course of time all the coastal regions of Canada will be known. Descriptions are prepared showing these things, so that the knowledge may be used by fishermen, sailors and industry.

Food in the Sea

Let us consider the life in the sea, particularly the fish, without which the earth could not possibly support its present population.

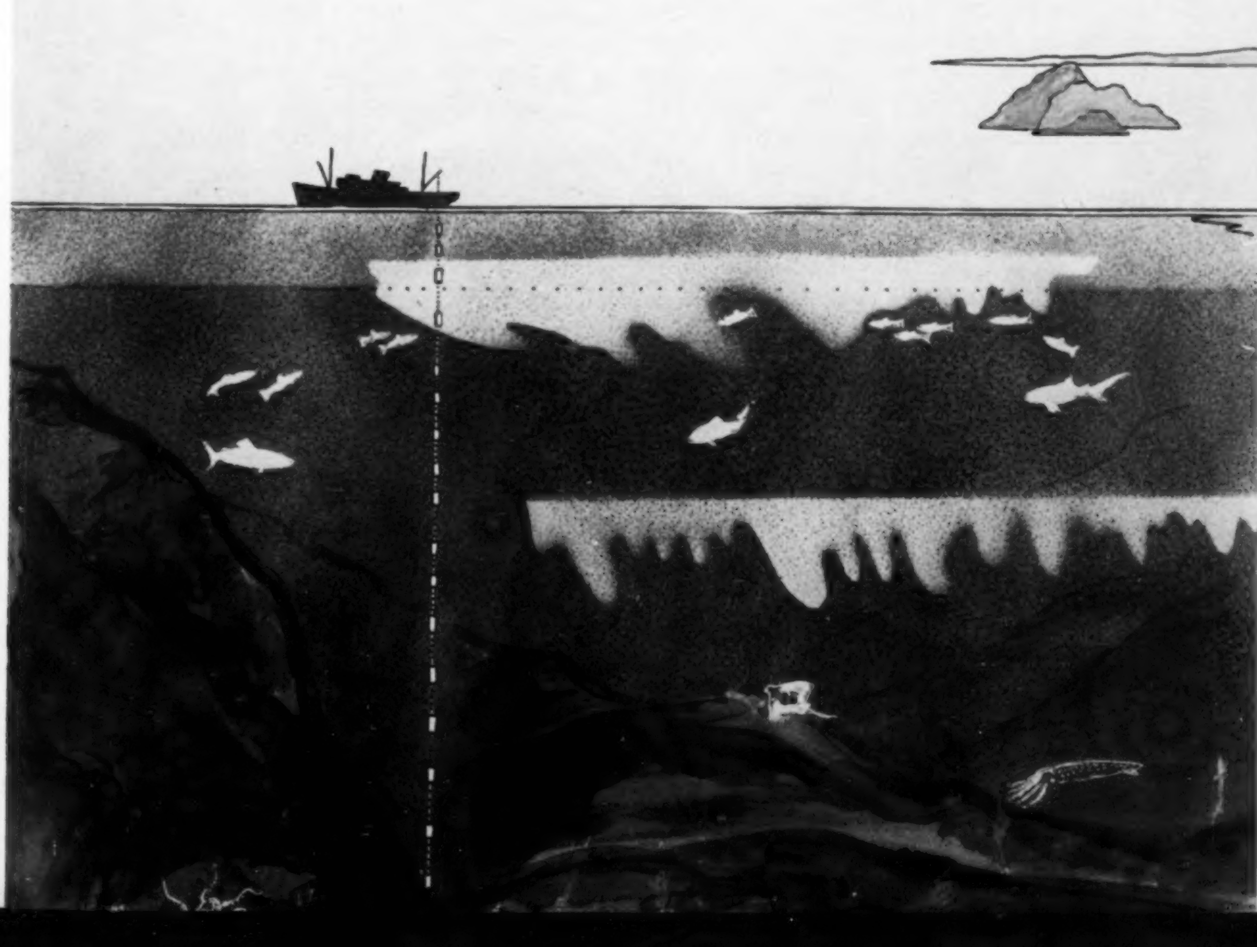
Fish are very much like land animals; each kind has its own preference in food and surroundings. They tend to congregate in the regions where their particular food is most plentiful and the climate is agreeable. Also they tend to travel at certain seasons of the year over well-defined routes. It is too much to suppose that they have landmarks in the fluid atmosphere of the ocean, or that they follow each other's trail. Rather they find the conditions more suitable in one direction than another, and they follow the lure of improving pastures.

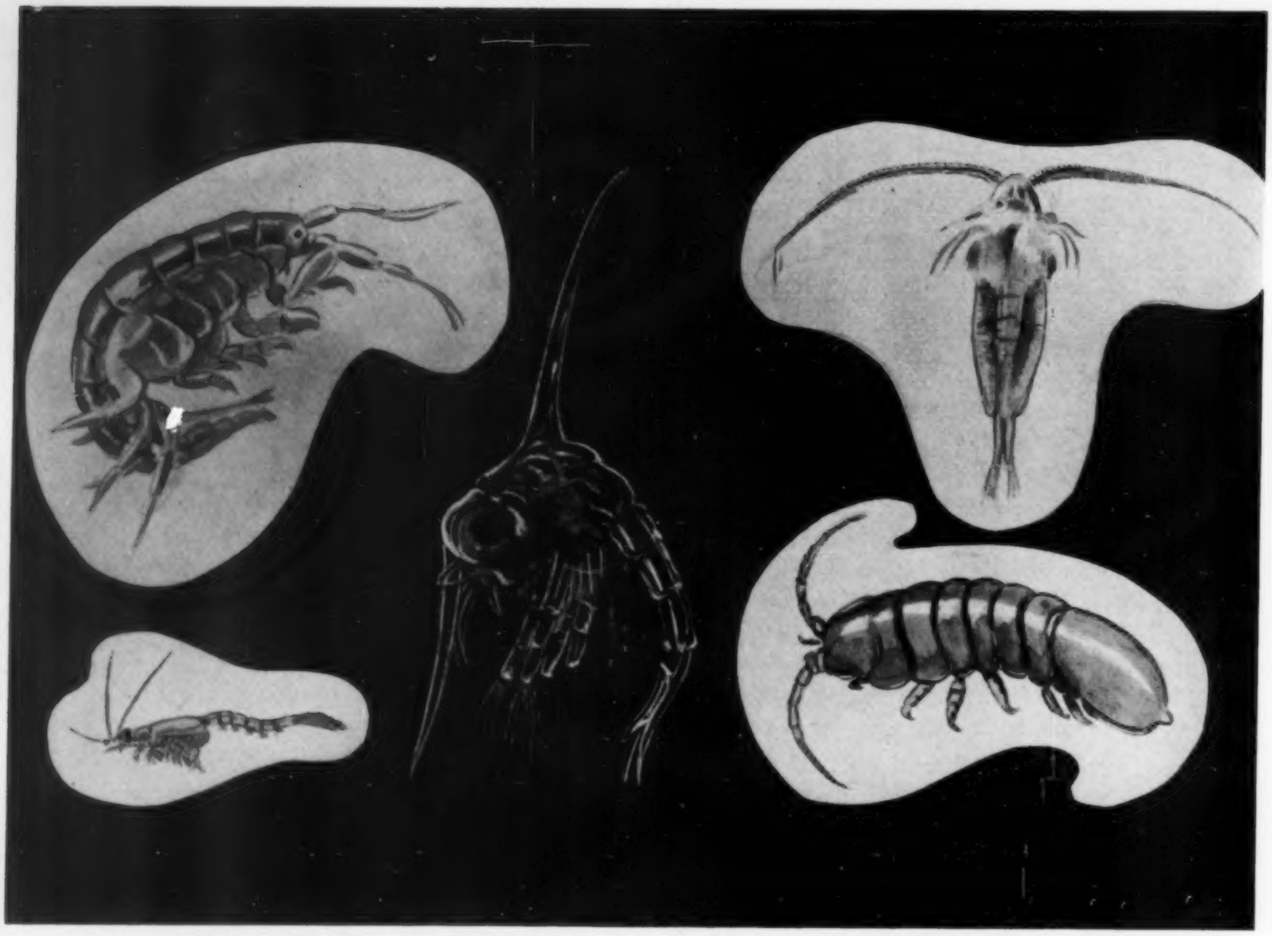
Food is undoubtedly the most important factor as far as the fish are concerned. The food is dependent on sunlight, dissolved chemicals, and temperature for its growth, and on the ocean currents for its location.

The primary foods are carbon dioxide and water. In the presence of light, green plants photo-synthesize these into carbohydrates—starch, sugar, cellulose. In addition phosphates, nitrates and silicates are the minerals required to promote growth. All these are present in the euphotic zone of the sea—the upper sixty to one hundred feet where the light penetrates, and plant life is possible. The chemicals are extracted by the plants, which are for the most part floating forms and occur in enormous numbers. They are microscopic in size and consist of skeletons of silica surrounding one-cell bodies. As spring approaches, the water along the coast changes from its natural clear sea-green colour to a murky brown, due to the enormous population of these plants that are collectively called *phyto-plankton*. Each spring, when the days lengthen and the water warms, there is a great bloom of phyto-plankton. This uses all the nutrients in a few weeks, and the euphotic zone becomes barren. As the dead plants sink, they rot—like garden compost—and the nutrients are redissolved in the dark depths of the sea. Here they are lost, until strong winds stir up the deep waters to fertilize the euphotic zone, then the phyto-plankton blooms again.

This phyto-plankton is the food of the *zoo-plankton*, the very small shrimp-like creatures barely visible to the naked eye, that occur in countless millions. These small animals form the staple diet of most of the commercial fishes at some stage. They are often found in large patches in the sea where they are designated by the fisherman as "red feed". The main concentration of plant life occurs between the surface and a depth of sixty feet. The zoo-plankton usually feeds along the bottom edge of this plant layer, but it also occurs at great depths where there is no light, and no phyto-plankton. Here the tiny creatures feed on each other, and on the plankton that has died near the surface and is sinking towards the bottom. The plankton rises towards the surface at night and sinks from the bright sunlight in the day time. It drifts with the currents from place to place, and lives or dies as the chem-

Phytoplankton (plants) occurs in the upper 60 to 100 feet of the sea where light penetrates. Zooplankton (animals) feeds below the plant layer. There is another layer of zooplankton between 1,200 and 2,500 feet depth. Samples of water are taken at intervals from surface to bottom.





Zooplankton are small shrimp-like animals, barely visible to the naked eye, that occur in countless millions. They form the staple diet of most of the commercial fishes and are called "feed" by the fishermen.

ical and physical conditions in the water are suitable or unsuitable. These small forms called "feed" by the fisherman and "plankton" by the scientist are the main food content of the sea, in the same way that plants and insects are the basic foods on the land.

The sardines, herring, and many other similar forms of fish feed entirely on plankton. Some salmon find sustenance on the shrimp forms, others are fish eating, and the codfishes are almost entirely flesh eaters. All of these are entirely dependent on the first link in the chain of "sea-food"—*the plankton*—plentitude of which determines the number of fish that any part of the sea will support. The great fisheries are close to land, or in the shallow seas less than 600 feet deep, where the nutrient elements, and the plankton are most plentiful.

In Canadian latitudes the phyto-plankton (plants) grows during the spring and summer while the water is warming; it dies off in the autumn, and the seas are cold and barren in the winter. The zoo-plankton (animals) follows this cycle, feeding and multiplying during the summer of plenty, and resting during the lean winter months. The fish are also very sensitive to these conditions and seek regions of suitable climate. The salmon prefer very cold water 35° to 50° F., during their life at sea, but on maturity they seek the coastal regions where the influence of fresh water leads them to the rivers. Some fish such as tuna prefer the saline tropical waters above 60° F. Some prefer the temperate waters between these extremes, the most important of which are the pilchards and herring.

The fish are also sensitive to small changes in climate from year to year. Atlantic herring are most plentiful when the water in their favourite haunts is a degree or two warmer than average. Pacific salmon are easier to catch when the coastal water is a little more saline than usual. Because of the many variations of weather and climate

in the sea, some parts are teeming with life, particularly the shallow seas close to the coast, while the central Pacific is as truly a desert as the Sahara.

There is reason to believe that there are epochal changes from time to time in the sea because some fisheries have appeared for no known reason and others have vanished just as mysteriously. An outstanding example of this is the disappearance of the herring from the Baltic Sea. Prior to 1477 this fishery was a staple food supply in northern Europe. About that time the herring disappeared from the Baltic and did not return for some centuries.

As everyone knows, fishing is a gamble. The fishermen must find the fish before they can catch them, and in modern fisheries every known scientific aid is used in the search. If we are able to predict when and where the oceanographic conditions suited to one of the commercial fishes will occur, it is not too difficult to direct the fishermen to that place. This prediction service has been highly developed in the Norwegian and Danish waters where the fishermen are directed to the best fishing grounds, day by day, on the basis of such oceanographic knowledge. There is considerable promise that oceanographic and fisheries research will provide similar direction for Canadian fishermen.

It is not likely that the sea can be farmed in the sense that the land is farmed because any efforts made by man are insignificant in the sea. Rather, the oceanographers study the areas of the known fisheries to learn why they are attractive to fish. Then they explore the seas to find areas with similar properties, knowing that fish should be there. As a result the fisheries of the world are reaching out from the shore, farther and ever farther into the ocean; for the cod in the North Sea and the tuna in the Pacific. Sometimes it is necessary to bring fish to the fertile parts of the sea. This was done when shad were introduced along the Pacific coast of the United States. They multiplied so well that in sixty years they have become a commercial fishery.

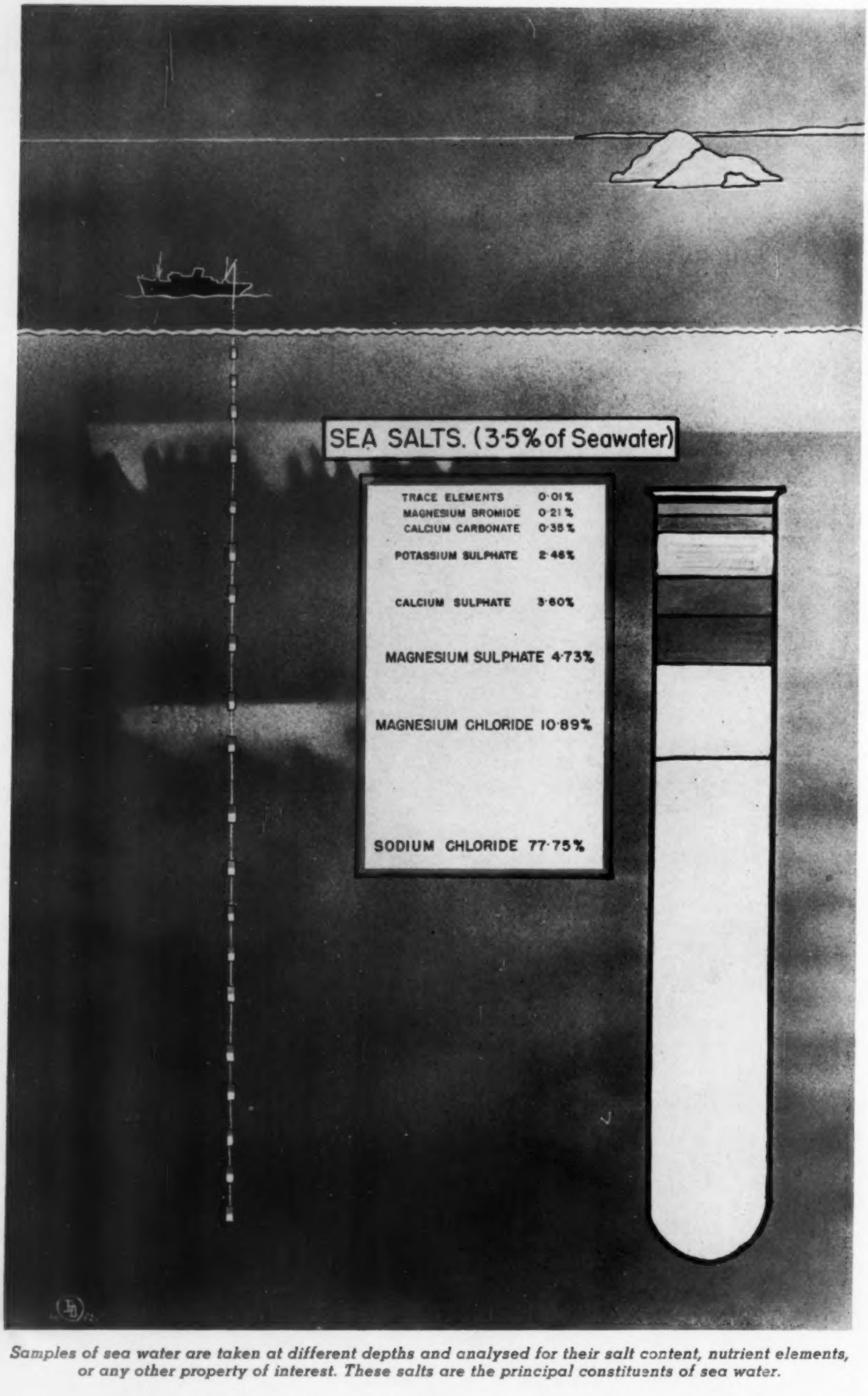
Recently oceanographers have found a great concentration of animal life between 400 and 600 feet depth over all the oceans of the world. Apparently this layer contains zoo-plankton and many fishes of the deep varieties. New fishing methods are being devised to catch these animals and see if they can be used for food. Thus scientific exploration of the sea reveals new fish, new fisheries, and new food.

Pacific salmon migrate from the sea into the inlets and bays of British Columbia, on their way into the rivers, where they spawn and die. Later the young salmon pass through these waters on the way to the sea. Many industries are located here and discharge their waste products into the sea water. Some of these, particularly the waste from pulp mills, would kill the fish if it were allowed to accumulate. Some pulp mills are located on, or near large seaways where the effluent is carried away by the currents. It is diluted with great quantities of sea water so that it does no harm. In other places it is necessary for the oceanographers to find ways and means of discharging the mill waste so that it will not kill the fish. Without this work valuable fisheries could be lost. Oceanographers make it possible for both fisheries and industries to operate together, and so maintain the wealth of the country.

The Salt in the Sea

The oceans and seas of the world contain 3.0 to 3.5 per cent of sea-salt. Near river estuaries the water is fresher, and in the Mediterranean it is slightly saltier. Every quart of sea water contains about an ounce and a half, or about three tablespoons of sea-salt.

To the chemist, a salt is a compound of a metal with a non-metallic element, or group of elements. When it is dissolved in water it separates into ions—molecules carrying electric charges. Common salt—sodium chloride—is a compound of the metal sodium with the gas chlorine. When dissolved in water it dissociates into positive sodium ions, and negative chloride ions. Sea water con-



Samples of sea water are taken at different depths and analysed for their salt content, nutrient elements, or any other property of interest. These salts are the principal constituents of sea water.

tains ions of 40 out of the 96 known elements.

One of the most amazing, and most important properties of sea water is that the ratio of the ions of the principal constituents to each other is constant. Sea water from the Mediterranean is more saline than from the Pacific Ocean. Ocean water has more salt than coastal water. In all these the ratio of chlorine to sodium, calcium to sulphate, or any other ratio, is constant. "Sea-salt" has a definite composition which is the same the whole world over, only its dilution varies.

The most abundant metals in the sea are the very light sodium, magnesium, calcium, and potassium. All these are so active chemically that they will burn in air, and all except magnesium react violently with water. They are all very essential to life and industry, and are obtained directly, or indirectly from the sea.

Common Salt

Common salt is probably the most valuable mineral in the world. Sixteen to seventeen pounds of salt a year is required for every person in the world. Not only is salt essential in food, but salt was the first, and still is the most effective preservative of food. The first trade was based on salt which was obtained by evaporating sea water in the hot dry climates. Salt continued to be a principal cargo for trade until the last century, when its recovery became a world-wide industry.

Salt is obtained from the sea, from salt lakes, and from salt beds in the earth, which are residues of former seas. In dry sunny regions near the sea, an area of low flat land is divided into ponds by low dikes. Sea water is pumped into the ponds in the spring, and during the summer the water evaporates in the sun. Eventually the 'solar salt' crystals are collected.

Here and there on the earth there are sea beds, such as the Dead Sea, and the Great Salt Lake in Utah, which are slowly drying up and concentrating salt. Salt is obtained from these in the same way as from the sea. In other places, such as Windsor, Ontario, the salt remains of such sea beds have been buried under the earth. These are mined by pumping water down to the salt, which dissolves, and pumping the brine up to shallow ponds where it is evaporated and the salt recovered in the same way as from sea water. In northern countries, where solar evaporation is not practical, the salt is recovered in huge vacuum evaporators.

These evaporation methods are so efficient that it is cheaper to recover salt from a mine, or a salt lake, than to transport it from the sea to inland places. Most of the deposits on land are being exploited to produce half the world's salt supply—about five million tons a year. All these deposits are insignificant compared to the sea. Every cubic mile of water contains enough salt to supply the world for nine years, and the oceans contain enough for two and a half million years.

More than half the current salt supply is used industrially. It is the source of soda (sodium carbonate), lye (sodium hydroxide), hydrochloric acid, chlorine, all chemicals that are necessary for industry or living.

Other Chemicals

Calcium is continually being extracted from the sea by shellfish, and is available in their shells or the limestone (calcium carbonate) deposits which are old shell beds. This is a stupendous process outranking all the chemical works of man through all the centuries. By heating the limestone or shell it is *calcined* to form lime (calcium oxide) and, when water is added to this, slaked lime (calcium hydroxide) results which is required in many industries.

Magnesium is the wonder metal that came into general industrial use after 1935 when its commercial recovery from sea water was undertaken by a brilliantly simple process. Slaked line (calcium hydroxide) is added to sea water. The calcium displaces the magnesium from solution. The magnesia (magnesium hydroxide) is then filtered off, treated with hydrochloric acid (made from salt) to form magnesium chloride. This is melted, and the metal separated by electrolysis.

Potassium is recovered from the bitter liquor drained from the salt ponds, after the common salt is precipitated. Chemists are still working on this to find a really efficient method of obtaining the valuable potash, which is necessary in all fertilizers. Thus the sea contributes to the fertility of the land.

Ethyl gasoline, which is so essential to modern motors, depends on an assured supply of bromine, the eighth element in the sea. Bromine recovery is simple, but necessitates the handling of huge quantities of sea water. Liquid chlorine (from sea-salt) is added to the sea water and displaces the bromine, which is blown out by bubbling air through the mixture.

In addition to these principal elements some of the trace elements such as iodine, are also recovered commercially. Even if these elements are only present in one part per million, there is so much sea water that their amount is enormous. Vancouver harbour which is about four miles long by a mile wide and about 70 feet deep contains about a ton and a quarter of gold, worth about one million dollars. Repeated attempts have been made to recover gold from sea water but so far have not been successful. The most spectacular of these was the German "Meteor" expedition to the mid-Atlantic in 1927. It attempted to obtain sufficient gold from the sea water to pay the German war debt. This and many other such problems await the chemists of the future.

The sea is the world's greatest storehouse of raw materials, and in many ways it is the most convenient. Industries based on sea water can be located on any coast, to suit their convenience. The biggest problems in mining the sea are to get rid of the water, and to separate the valuable elements from the salt. In recent years chemists and engineers have so improved methods that it is now practical to extract minerals that are present only in minute amounts. Nowhere have the techniques of modern science been applied more spectacularly than in the recovery of materials from the sea.

Development of Oceanography

The world's greatest need is food. Increased agricultural efficiency may produce enough starches, sugars, and vegetable fats, but not enough essential protein. If the world's increasing population is to be fed more food must be produced. New sources must be found. The sea is the only remaining hope of feeding the increasing population of our shrinking world. There is no famine in the sea. The science of oceanography is contributing much in determining ways and means whereby the sea may increasingly supply food to meet world population requirements.

Following the great exploratory voyages of the fifteenth and sixteenth centuries, the exploration and charting of the world was undertaken by the navies of the great powers. Time and tides became very important, and the Royal Observatory was founded by Charles II at Greenwich (1675). Charts were a necessity for seaborne trade to far away places. The Admiralty Hydrographic Department was established in 1795. There was a frenzy of work to know and exploit the new highway of the sea, to reach new lands and supply the demands of the world's expanding population.

In the last century young Lieutenant Maury (1806-1873) of United States Navy conceived the idea of collecting records from all the ships at sea, and making charts showing the average winds, and currents experienced in each part of the ocean, in each month of the year. This defined the great ocean and coastal currents, and is so valuable to mariners that it is still continued in the Pilot Charts, published monthly by the U.S. Hydrographic Office.

All this concerned the surface of the sea; people still fished, and obtained their salt by the ancient methods. The deep ocean was a mystery, and as late as 1860 it was still thought by many to be solid ice. Then John Thompson (1824-1907), later Lord Kelvin, while working for the trans-Atlantic cable, made a sounding machine (1873) by which the great depths could be measured and the route for the cable surveyed. New

C.N.A.V. Enkoli, *the oldest oceanographic vessel now in service in Canada, ties up at a Pacific coast fishing port. Oceanographers work closely with the fishermen.*

wonders were revealed. The sea was salt water from surface to bottom, it was cold, but there was no ice. There was life in the deep ocean.

Science was aroused. In 1873 the first of the great oceanographic expeditions, in H.M.S. *Challenger*, sponsored by the Royal Society and financed by the British Government, set out on a three year voyage over all the oceans to examine the saltness of the sea, the gases dissolved in the water, and the life in and over the ocean. The chemist, John Buchanan, brought home 77 carefully collected samples of sea water from all oceans. These were analysed by Dittmar in Glasgow University (1884) and showed that the composition of sea-salt was constant in all the oceans.

Since then there have been a number of these great expeditions, searching the seas like the explorers of the previous centuries, seeking great depths, studying the polar ice, finding the regions rich in life, and the desert areas. These great expeditions still go on, and are still revealing new, and most important facts.

At the turn of the century the countries bordering on the Baltic and North Seas formed an International Council for the Exploration of the Sea in which they shared the work and pooled their knowledge of oceanography and fisheries. Between World Wars I and II, oceanography was sponsored by the Fisheries Departments of Japan and Canada in the oceans near their coasts. The Prince of Monaco personally supported studies in the Mediterranean, and a number of private institutions in the United States made many notable contributions.

During this period oceanography was regarded with some suspicion, much as physics and chemistry were regarded in the eighteenth century. There were a few "great" expeditions, but most of the data and knowledge were gathered by diligent scientists working from fishing boats, patrol vessels, and naval ships. These obscure men persevered and prevailed, so that oceanography is now established as a recognized field of study. Since World War II the countries of the world have been competing to expand and improve knowledge of the sea and apply it to social and industrial ends.

The borracho *reeling home at dawn with his basket of snails for the family table, echoes the weird Andalucian song of the night watchman.*

Malaga: Spain's Port of Sunshine and Tragedy

by EILEEN JENNESS

Illustrations from original drawings by the Spanish artists Sanches Vargues and Jose Rokero

It is Sunday morning in Malaga. An ascetic pall reigns over our Western cities on this day; but all Spain, at the first rays of the rising Sabbath sun, awakes to an uninhibited fiesta-mood. The cocks have been crowing in the distance for hours, answering one another in the intervening spaces right up to the syncopated excitement in the coop beneath my window. The aged night watchman pacing to and fro at a nearby garage, is

A small boy and his much loved burro make their way to market with their load of Moorish pottery jars filled with fresh goats' milk.

still singing at dawn the weird Arabic trills and cadences of his native Flamenco — his aria echoed down the street by a happy-hearted *borracho* (drunkard) reeling home in the last hours of darkness. Penetrating explosions from the exhausts of a fleet of motorcycles tuning up for their weekly race in the central Esplanade, make the air hideous; and a miniature burro emits a roar, quite unbelievable from so tiny and patient a creature, as he trundles his early load of pale green cabbages, or of Moorish jars filled with fresh goats' milk, to the Sunday morning market.

Abandoning sleep, I look down upon the scene from my window high up in an apartment house overlooking the quay. It is still dark. The forms of watchman, *borracho*, and vendor take on strange outlines as they move eerily across my view. Suddenly, the sunrise breaks across the dark horizon of the Mediterranean. It casts long streamers of light — rose, amber, and gold — obliquely over tall chimneys, fishing boats in the harbour, the ancient Arab fortress on the hillside, and the mountains that form the backdrop; and all Malaga takes on a dreamy Sisley-like appearance, which in the reality of daylight it so emphatically denies. For life in this small Spanish port, fascinating though infinitely sad, betrays in the light of day every evidence of man's inhumanity to

A young peasant hauls a heavy load of dried olive branches from the country to the city market to sell for firewood. Olive wood is used exclusively for firing pottery.

man, and the failure of governments to cope with the social problems of our time. Poverty — gaunt, starving, tubercular — stares one in the face from every corner; professional beggary, though prohibited by law, thrives here on the compassion of well-fed tourists who spend a few days or weeks in Spain's port of continual sunshine. Stealing from foreigners is the easy profession of unemployed youths, and though the self-respecting population (a vast majority) deplores the practice, foreigners themselves encourage it by their display and carelessness.

Below me I see the Lilliputians one by one issuing from the doorways of their small whitewashed houses, moving hither and yon about the square and the quay in the endless search for work and food. Even at this early hour streams of vendors, mostly men in the shafts of their own carts, are dragging to market their loads of oranges, vegetables, firewood, or alfalfa; inarticulate animals in this orgy of noise, these patient creatures just plod along in silence. At the end of the Plaza two gates open and pour out a battalion of street-sweepers, their green iron push-carts resounding on the cobbled streets with the noise of a battery of howitzers; and in this misty half-light they might well be taken for such. Like ants in ragged, grey-green uniforms, they scud into laneways here and there, each to his particular hunting ground, dragging cart and palm-frond broom, carrying on his arm a home-made wooden dustpan, and throwing over his shoulder the long string handles of a small oval basket that loads and unloads the debris of the day. Two of them stoop to tidy up a laneway nearby; they sweep the hardened mud roadway with the zeal of a careful housemaid, but the improvised wooden dustpans fail them at the last moment, and leave telltale piles of dust and rubbish all along the street.

Soon black forms of women pass to and fro from the market place, their baskets empty or overflowing with vegetables and fruits of every colour and variety. I see others coming and going from early morning Mass, recognizable as dévouées by black lace mantillas thrown over their hair, a soft touch of artistry that relieves an otherwise colourless picture. Often their men follow in small groups, the 'clerk' class husbands and sons, dressed also in traditional black, with blue-black hair greased and brushed to shine like the plumage of grackles. More ragged but more picturesque come the vendors of fish, with weird raucous cries, shuffling their

Even today the motor-car has not replaced the stoical, reliable burro of Spain. This very old lady rides to town to church on his back; dressed in Sunday clothes, she wears a scarf over her head instead of a more expensive lace mantilla.

way to town from the outermost quay of the harbour. With flat-bottomed, circular baskets slung over their elbows like a set of balanced scales, they move rhythmically beneath my window with their wriggling load of cuttle-fish, octopus, and large and small fishes of unimagined colour and shape. Even before dawn breaks, with an eye to the latest market values, they have carefully selected their produce from the squirming harvest unloaded on the wharf by fishermen just returned from their night-long quest at sea.

Now two or three mechanics from neighbourhood auto repair shops have dragged decrepit cars from the dark confines of their windowless garages out on to the sun-lit square, where soon they will hammer and grind with the enthusiasm of village blacksmiths. In their open-air workshop, warmed by a hot sun, they will clean, grease, take apart and reassemble engines, mend tools, and improvise parts, at an unpressed tempo amidst the gossip and laughter of their rivals. In Spain, as in her sister country Italy, one can rely upon the work of any casual mechanic from the most meagre workshop, even in remote hamlets; for he has taught himself the mechanics of every local machine by the process of taking apart and reassembling, and he has learnt from childhood to improvise and to 'make do', through his very lack of money and opportunity. All he asks in return, is faith in his work, a little cash, and complete abandonment of all time values. From a dark alleyway two men trundle out a tiny improvised forge, an iron

basin on legs, filled with glowing charcoal which they fan from time to time with a pair of pig-skin bellows; this quaint little furnace, produced at the psychological moment by these two boys with a timely sense of business, will provide the forge for tempering and welding for all the garagemen now gathered on the square.

A small boy, bare-legged, a pair of patched cotton trousers covering his thin body, a ragged shirt on his back, and a curious cap topping his unkempt hair, comes running across the quay. Throwing his old sack and basket on the ground, he crouches in front of a wall, and, like a hawk searching for its prey, he scans the square in front of him. A building is to be erected here within a few weeks, and the 'pickings' of the square are becoming scarcer and scarcer. Suddenly his eye catches sight of a small pile of burnt-out charcoal — the residue of a fellow-beggar's fire of chips of the night before. The child crouches over the charcoal, raking it to and fro to separate the ashes from the coal; he throws a few small pieces of the charred wood into his empty bag. Seeing this figure searching so earnestly in the rubble, other ragged gamins join him, attracted like flies hovering over some dead thing, and presently five small gypsy-like forms are all scraping away at the same barren heap. One of the group, fairly clean and tidy, and fully clothed, is actually on his way to school, but the fascination of the search, and the 'sophistication' of the company have proved too heavy a temptation; he squats down beside them, his neat case of books put far to one side, and begins to play a game of pebbles with one of the less eager scavengers. Across the square I see the same tragic drama being enacted by two grown men with baskets and gunnysacks; but they stop to light each other's home-made cigarettes, and to have a sympathetic chat, instead of playing the game of casting pebbles.

Later in the day, a strange child whom I have not before seen in the neighbourhood, arrives carrying a tattered basket sagging with the weight of its load. He searches the rubble square with his eyes, finds a spot that is fairly deserted, and, glancing cautiously to right and to left, runs swiftly to the spot and begins to dig violently, like an anxious red squirrel pawing up pine needles at random in her haste to cache her winter supply; presently he tilts the basket over the hole and empties the contents into it. Smoothing over the surface, he straightens up, pulls his ragged clothing into place and walks away as though he too has been merely searching. A little later a gaunt character of about twenty-five years, who has been lounging suspiciously in and out of the garagemen's improvised workshop, spies a large sheet of heavy paper or linoleum in one of the assembled trucks. He awaits a moment when the men go into a huddled conference over a difficult piece of welding; unnoticed, he quickly snatches the sheet from the truck, deftly slips it up his back underneath his coat, smooths down the coat from shoulder to the edge, and, satisfied that no one has seen his lucky if meagre haul, walks casually down the street.

And so, by the fair means of honest labour, and by the foul means of tragically unrewarding tricks, the endless search for even a fraction of a peseta's worth goes on all through the day and the night; only the people in the scene change as, discouraged and disgusted, the actors give up their fruitless search and move on to a new setting.

By mid-afternoon a few dark clouds have overcast the sky. The sun disappears; and the harbour, a moment ago brilliant iridescent blue, now takes on the ominous metallic grey that warns fishermen assembled on the quay of an oncoming storm and the need to prepare against every hazard before leaving the safety of the mole.

Below me, in the distance, a strange procession makes its way slowly down the laneway that passes my apartment. From the fantastically plumed white horse in the lead, I presume that the Sunday circus, an almost weekly occurrence in every community of Spain, has 'folded up its tents and is quietly stealing away'; but as it approaches, I realize that this is not a circus, but a funeral procession carrying the body of one more

Ragged but picturesque, the fish vendors, with flat-bottomed circular baskets slung over their elbows, shuffle their way to town with their loads of cuttle-fish and octopus.

At many villages along the coast of Spain, oxen help the fishermen beach their heavy boats in the early morning hours, when the tide is at low ebb.

Spanish child to its green bed in the cemetery on the hill. The great white-plumed horse, laden with a saddle of bizarrely emblazoned white satin, is drawing an all-white hearse, ancient, heavily carved, and bedecked with much white embroidery. Through the glass sides of the carriage one can see a solid cloth of tightly woven orange-blossoms and white jonquils covering the small coffin. (How often had I seen the mothers of the poor sitting on the floor in a corner of the Cathedral, earning a few pesetas by weaving these robes of flowers for the biers of Malaga's dead, bourgeois and beggar alike!) On foot behind the hearse, a hundred or more black-clothed figures, with heads bowed, walk slowly in double file. The sad little procession passes on, down the narrow laneway, down past the quay — where a great luxury liner from America is disgorging its tourists — then threads its way in and out of the tangled streets that lead to the steep hillside road. Soon the white-plumed horses, the embroidery-bedecked carriage and the straggling mourners disappear from view. Behind a tall grove of cone-shaped cypress trees, that unmistakable landmark in Spain and in Italy, the small child is laid in the earth — a last green haven where sorrow can scar him no longer.

EDITOR'S NOTE-BOOK

Dr. Ian McTaggart Cowan (*Smaller mammals of the Western Mountains*) has been professor of Zoology at the University of British Columbia since 1945. His description of the smaller mammals makes an excellent sequel to the article he published last year on the *Big Game of the Mountain Province.*—Anne Glyn-Jones (*The Valley*) served in the WRNS in England and at Gibraltar during the war. Later she went to Switzerland where she worked on the World Health Organisation. She is now in Ottawa and has been a student at Carleton College. —John Patrick Tully (*Oceanography*) has been a member of the Fisheries Research Board at its Pacific Biological Station, Nanaimo, B.C. since 1931. As oceanographer-in-charge of the Pacific Oceano-Canadian Joint Committee he has made many valuable contributions to our knowledge of oceanography.—Eileen Jenness (*Malaga, Spanish Port*) has travelled widely in Europe and America with her husband Dr. Diamond Jenness, formerly Dominion Anthropologist at Ottawa. She has published numerous articles on her travels and a book on the Indian tribes of Canada.

AMONGST THE NEW BOOKS

I Cannot Rest From Travel

by Willard Price

(John Day Company, New York, $4.00)

Titillating is the word for Willard Price's autobiography. He presents in entertaining manner some of the highlights from a lifetime of wandering. Well, almost a lifetime, for he confesses in the first chapter that until the age of four he "lived a fairly provincial life" in his native Peterborough, Ontario. His first journey took him some nine miles away and the people looked strange. On his remarking that they were funny, his father replied "Probably we look just as funny to them". "Perhaps that was my introduction to the problem of international understanding," writes Price. And when at the same tender age on his first fishing expedition, his father having assured him that fish are good to eat, he takes a bite at an active sunfish that flips back into the water, he says "Perhaps that was my initiation in the critical attitude". After that, I had to go on reading. Perhaps he tries to cover too much ground in one book (he knows seventy countries) and sometimes he is trite but, like a good appetizer, he leaves one with a taste for more.

Mr. Price does not burden the reader with the problems inherent in world travelling — how to finance it, the difficulties of equipment and transportation, the domestic trials. As roving reporter, freelance writer, field worker for museum and geographical society, he made his way, and he made it almost everywhere you can think of. But if his nature is to ramble, his style is not. His chapters are tightly knit, graphically descriptive, and they display insight and understanding and a pleasing sense of humour. M. FELTON

The Thomas Cook Story

by John Pudney

(Michael Joseph Ltd., Toronto, $5.50)

The story of Thomas Cook and of his son, John Mason Cook, forms an illuminating comment on the development of modern travel. The beginnings were most unpromising and gave no hint whither the path would lead, which adds piquancy to the brilliant story of success. Certainly Thomas Cook's early career as a hawker of vegetables, a cabinet maker, a printer, a Baptist missionary and a temperance reformer would hardly seem a suitable training for a universal travel agent. But having once determined to arrange a special train for a temperance meeting, the rest was, by comparison, easy, and Cook was soon conducting thousands of his fellow countrymen all over the British Isles. Then he crossed the English Channel and took them to Paris, and on to establish "le playground de l'Europe" in Switzerland. There were setbacks, and some people sneered contemptuously at Cook's tourists, which did not deter Cook from conquering the rest of Europe; and in 1865 he set about the conquest of America. Soon he was shepherding British tourists across the Atlantic and taking them to visit the recent American battlegrounds by rail at a cost of two cents a mile.

After a preliminary try-out in conveying the royal cattle which Queen Victoria was showing at the Vienna exhibition of 1872, there followed many royal journeys to be catered for, and the amazing variety of scope in the business of transportation is one of the most interesting features of this book. No commission was too difficult for the dogged spirit of the Cooks, father and son. There were relief trains to be organized bringing food to the starving people of Paris after the Franco-Prussian war; arrangements to be made on behalf of the government of India for pilgrims to Mecca; and the conveying of troops to Egypt for the relief of Khartoum.

Three generations of Cooks were actively concerned in the management of the ever-increasing business, but wartime conditions brought about inevitable changes of ownership as there were vast alien financial interests involved, and it has now become a British Limited Liability Company. It is an inspiring story of human enterprise, surmounting every obstacle, keeping abreast of the times, till at last the project which started in 1841 with a single excursion train from Leicester to Loughborough, today carries some ten million people yearly to every corner of the earth. S. SEELEY

The Look of Maps
An Examination of Cartographic Design

by Arthur H. Robinson
(University of Wisconsin Press, $2.75)

This is a book about map making and not a book of maps. Indeed its 105 pages are almost devoid of visual illustration for they include but a single diagram and not one map. It is, therefore, unique in modern geographical literature. But it is unique, not only from the point of view of what it does not contain as what it does contain. For *The Look of Maps* is one of the rare analytical studies on map making. It is a scholarly, thoughtful and stimulating critical examination of the elements of cartographic techniques — the methods by which data is presented in map form. The elements considered are the importance, style and use of lettering, map structure and design and the function and use of colour. In the discussion on these topics, which Professor Robinson presents, he indicates how far our knowledge of their problems has progressed as well as the avenues which future development might take in order to solve them. The extensive bibliography is a further aid in the exploration of this vital subject.

NORMAN L. NICHOLSON